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ABSTRACT

This teacher's guide contains activities to use in conjunction with a site visit to the Hopewell Furnace National Historic Site (Elverson, Pennsylvania). The guide provides diagrams of the furnace, a cold-blast smelting operation, and the furnace operation. It presents a timeline of iron production from ancient times through contemporary times. The guide offers nearly 50 pages of activities about the Hopewell Furnace site, from crossword puzzles to vocabulary to historical activities to a visualization activity. (BT)

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Teacher's Guide

Hopewell Furnace National Historic Site

2001

Hopewell Furnace National Historic Site
2 Mark Bird Lane
Elverson, PA 19520

http://www.nps.gov/hofu/teachers/index.html

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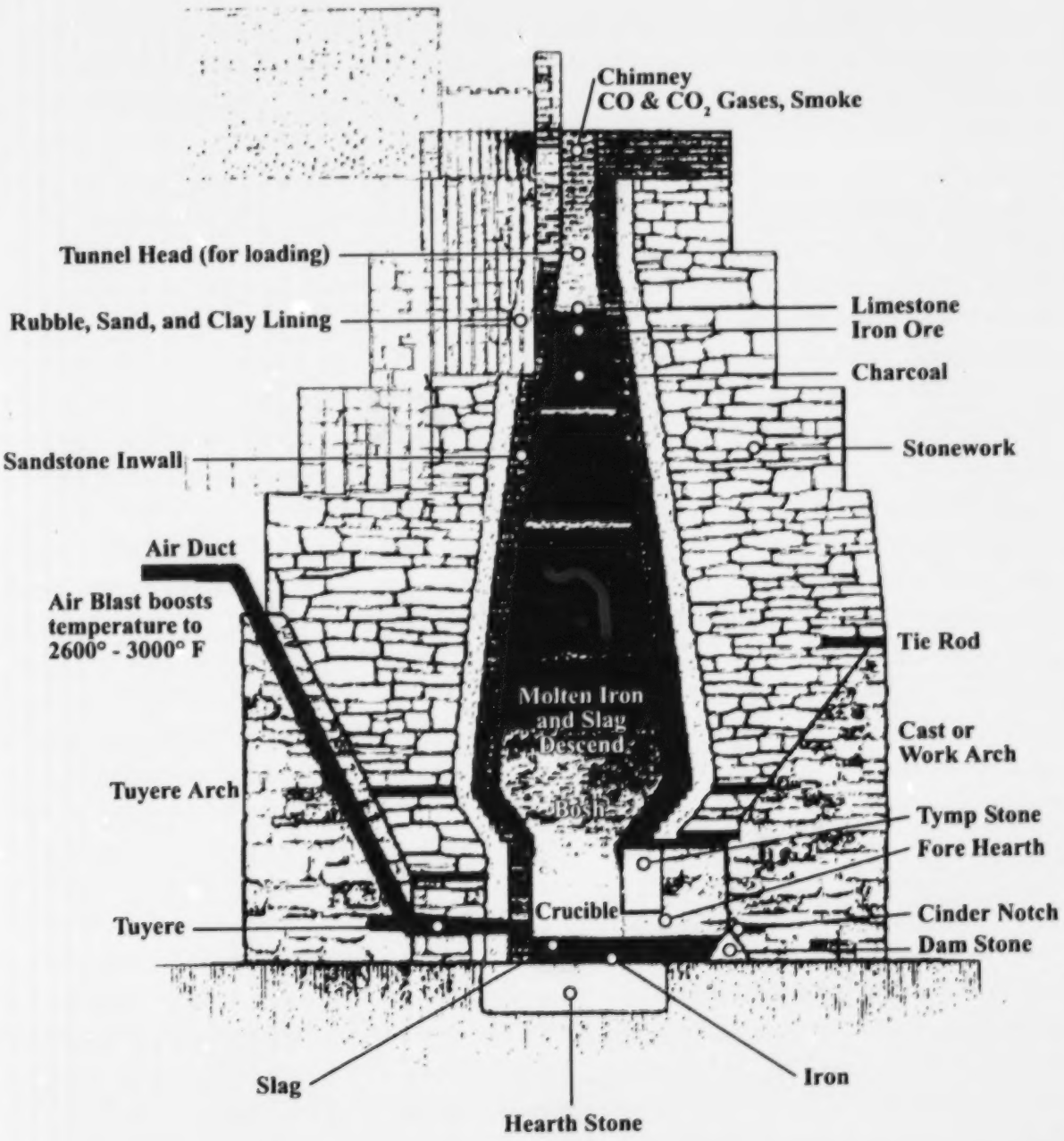
The Furnace, A Cold-Blast Smelting Operation



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Filler
Laborer
Founder
Gutterman
Moulder

Hopewell Furnace Chronology

B.C.

3000	Iron first produced in Asia Minor (Turkey)
2000	Iron produced in Nubia (East Africa)
1800	First iron weapons made by the Hittites (Turkey)
1050	Iron produced in Greece
790	Iron produced by Nok Culture (Nigeria)
512	Iron produced in China
400	Iron produced by Celts of Southern Britain

A.D.

300	Iron produced by Romans
1000	First iron produced and forged in North America by Vikings in Greenland and northern Newfoundland (Canada)
1543	Survivors of Spanish expedition led by Hernando DeSoto produce first iron forged in future United States (Arkansas)
1621	First blast furnace in British colonies built at Falling Creek, Virginia - destroyed by Native Americans before going into production
1644	First successful iron works in British colonies established at Braintree, Massachusetts
1710	Coke is invented in England - used as fuel in iron furnaces
1716	Thomas Rutter builds bloomery forge near what is now Pottstown, Pennsylvania
1720	Thomas Rutter builds Colebrookdale, the first blast furnace in the American colonies, near Pottstown, Pennsylvania
1732	Samuel Nutt's bloomery grows into famous Coventry Iron Works (Coventryville, Pennsylvania) the first steel furnace in Pennsylvania
1740	Sands Forge on Hay Creek in Berks County started by William Bird, father of Mark Bird, first owner of Hopewell Furnace
1742	Benjamin Franklin invents the Pennsylvania Fireplace
1744	Hopewell Forge built by William Bird

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A.D.

1750 Iron Act, limiting the ability of colonial iron industry to produce finished products, passed by British Parliament

1761 William Bird dies leaving estate to son Mark

1762 At Carron Ironworks in Scotland the first cast iron is converted into malleable iron

1771 Hopewell Furnace built by Mark Bird, using slaves and free laborers

1772 Oldest known product produced by Hopewell Furnace, a six-plate stove

1775 Beginning of the American Revolution

1776 Congress advances Mark Bird $2,000 to cast cannon

1777 The Board of War discharges Hopewell Furnace workmen from militia, stating their work at an iron furnace was more important than their service in the militia

1778 Mark Bird ships a thousand barrels of flour down the Schuylkill River to Washington's troops at Valley Forge

1780 Gradual Emancipation Act passed in Pennsylvania (most slaves in Pennsylvania worked in iron industry)

1781 General Cornwallis surrenders to General Washington at Yorktown, ending American Revolution

1786 Because of debt from war and poor economy, Mark Bird puts Hopewell Furnace up for sale; no buyer found

1788 Hopewell Furnace property auctioned off and Mark Bird flees to North Carolina to escape remaining creditors

1800 Daniel Buckley and his brothers-in-law Thomas and Mathew Brooke purchase Hopewell Furnace for 10,000 pounds sterling; 5,000 acres, two mines, and the furnace are included

1807 Jefferson enacts U.S. Embargo Act, limiting trade with Britain and France

1808 Buckley-Brooke partnership closes Hopewell Furnace because of trade embargo and legal problems with William Penn's heirs over land grants

1815 Congress enacts protective tariffs

1815 Opening of the Schuylkill and Union Canals

1816 Mark Bird dies in North Carolina

1816 Hopewell Furnace goes back in blast, after being shut down for eight years

1826 Hopewell Furnace produces door frames and peepholes for Eastern State Penitentiary in Philadelphia

A.D.

1828 Hot blast iron smelting developed in Scotland (preheated air was blown into furnace) producing more iron with less fuel

1830-1838 The most prosperous period at Hopewell Furnace occurs under the guidance of ironmaster Clement Brooke, son of Mathew Brooke; in 1836-37 the furnace is operated continuously for 445 days and produces 1,160 tons of castings, earning over $40,000 gross for the owners of the furnace; furnace workers earn from $200 to $300 a year

1837 Bank panic; depressed economy causes major setback to iron industry

1838 Pennsylvania legislature authorizes corporations to make iron using coal as fuel, contributing to decline at Hopewell Furnace

1830s-1850s Runaway slaves on the Underground Railroad occasionally use Hopewell Furnace as a stop on their journey from the South

1839 Opening of the Philadelphia and Reading Railroad; Hopewell Furnace makes its first shipment of stoves by rail

1844 Stove casting ends at Hopewell; only pig iron is produced from 1844 until 1883

1853 Anthracite furnace constructed and put into blast at Hopewell Furnace - proves to be unsuccessful and shut down in less than two years

1861-1865 The Civil War; the price of pig iron (the only product made at Hopewell Furnace during this time) rises from $30/ton to over $90/ton

1861 Morrill Tariff Act places strict duties upon imported iron and steel; helps Hopewell Furnace continue to produce iron during and after the Civil War

1883 Hopewell Furnace shuts down after 112 years of operation

1935 Hopewell Furnace purchased by the U.S. Government; Civilian Conservation Corps begins restoration of furnace community

1938 Hopewell Village established as National Historic Site, becoming the first site in the National Park Service to commemorate our industrial history

1985 Hopewell Village's name changed to Hopewell Furnace National Historic Site

Present Approximately 100,000 visitors a year tour Hopewell Furnace National Historic Site

Hopewell Furnace in 1836

A Visualization Activity

These descriptive paragraphs can be read to students in the classroom to prepare for their visit to Hopewell Furnace National Historic Site or can be read while at the site. Ask students to close their eyes and imagine work and life at historic Hopewell Furnace. It may be helpful to review vocabulary words before reading this activity to your students.

The year is 1836 and you are on your way to visit relatives at Hopewell Furnace. The dirt road is full of potholes and you bounce painfully on the wooden seats of the wagon. Your father is sitting beside you and he lets you hold the reigns. The leather reins have been recently oiled and are sticky in your hands. It's a warm summer day and you feel the sun on your face. Flies buzz about your eyes and ears. The work horses swish their tails at the large flies trying to bite their hindquarters.

You are hungry and tired, but anxious to see your cousins. As you near Hopewell, the trees disappear and the smell of smoke and fire invades your nose. The winding road takes you through recently cut acres of forests. Several cords of wood are piled along the road. On the right, below the hill, a collier is tending a charcoal hearth. He waves to you with one hand, while in his other hand he holds a shovel. You watch as he shovels dirt on the huge mound to put out a small fire. You can see at least four other hearths burning below you. Your eyes tear and start to burn from all the smoke. You snap the reins and the horses gallop through the smoke. You breathe in big gulps of fresh air as the charcoal hearths are left behind.

The road straightens and passes through some young trees. This area was cut and cleared for charcoal some years ago. You can still see the circular scars on the ground where the charcoal pits were located. The trees, however, look healthy, and some weeds are beginning to grow over the black scars. An abandoned collier's hut dominates the top of a small hill to your left. The timbers that once stood erect have fallen in a heap. The pipe of an old stove sticks out from the debris.

As the wagon rounds the bend, you hear voices in the distance. You hear the rhythmic pounding of metal against stone… clink... clink... clink... You know you are at the Jones' Good Luck Mine and only a few miles

away from Hopewell Furnace. Here at the mine, the men are busily swinging their picks into the hard iron ore. The surface mine looks like a giant pit dug into the ground. Alongside your wagon a boy pushes a cart full of ore. He throws a piece of ore to you and you catch it. The heaviness of the rock surprises you. The ore is dark, but has rust-colored streaks of iron in it. Your father tells you not to keep the piece of iron ore, so you toss it back to the same boy.

As you look up into the clear sky you see a thin wisp of smoke in the distance ahead. You must be close to Hopewell Furnace! You stand up in the wagon and look down into a valley surrounded with gentle sloping hills. The hillsides are treeless from the work of woodcutters and the colliers. French Creek cuts through the middle of the village, meandering its way through the fields and cut forests. From this distance it hardly seems larger than a trickle. Tiny houses and buildings dot this valley. The buildings were once white but are now a dirty grey color. You can see many people around the buildings, in the field and in the gardens.

The smoke that you saw from the distance is billowing from the chimney of the furnace. There is a bad smell coming from the furnace stack. It smells something like rotten eggs. As you near the furnace, two men are pushing carts of iron ore, charcoal and another rock (this one is lighter in color) called limestone. The wheels of the carts squeak as they roll toward the top of the furnace. You can barely see into the brick building, but you watch as the men dump the ore, limestone and charcoal into the chimney. One man turns away from the intense roar of smoke, fire and heat. His skin is glistening with sweat from the heat of the furnace. You too can feel the heat of the furnace. The horses snort from fear. Your father leads them down the hill, past the office and store, past the Big House and around the bend past the barn.

Your father stops to talk to the blacksmith and you get out of the wagon. You stand in the doorway of the cast house. Over to the left men are pounding sand into wooden boxes. There are at least six of these moulders, plus their apprentices, working at benches. They are making molds for stove plates. Everywhere is dust, dirt and heat! The one cool spot is over by the waterwheel. The giant wheel lazily turns and water is occasionally splashed into the dusty room. All of a sudden a loud bell rings right above where you're standing! The clanging of the bell creates quite a stir of activity in the casting house. Men start appearing from all directions. One man, still munching on a dinner biscuit, brushes past you. The smell of the freshly baked bread reminds you of your hunger.

As you watch, a tall, muscular man with his sleeves rolled to his elbows picks up a long iron rod and walks toward the dam stone of the furnace. The moulders are bustling about and shouting as they stack their molds in a row and grab ladles and crucibles. There is excitement in the air. All the men become silent as the man with the rolled-up sleeves (you later learn that he is Tom Care, the founder) knocks out a clay plug from the top of the dam stone.

Red, hot liquid bursts out of the furnace. The liquid is so hot it bubbles as it is channeled into a pit on one side of the furnace. This is the slag. Then the man returns to the furnace and knocks a clay plug from the bottom of the dam stone. Now a purer liquid rushes from the furnace. This is the molten iron. Each man scoops this boiling liquid into his brace and ladle, returns to his work station, and carefully pours this molten iron into sand-cast molds. You smell burning sand; you see bubbling, molten metal; you hear the groaning of the waterwheel, roar of the furnace, and the heavy sighs of the men working; and you feel the excitement of this activity as the moulders and their apprentices hurry past you to do their important and dangerous jobs.

Your father calls your name and you slowly saunter back to the wagon, keeping your eyes on the furnace and all of its activity. The horses plod past the blacksmith shop, across the French Creek bridge and toward the employee tenant houses. Clothes are drying on a line. A large, black kettle is hanging over an outside fire. Two girls are sitting in the shade of a sycamore tree churning milk into butter. In a large garden, one woman and two small children are pulling weeds. The children are covered with dirt and laugh as they throw weeds first at each other and then into a pile. A few chickens are following the young gardeners, scratching the dirt and picking through the weeds. As the woman slowly stands and straightens her back, smoothing her skirt and apron, she shields her eyes from the sun and looks toward your approaching wagon. A smile spreads across her sunburned face and she waves heartily to you and your father. You recognize your aunt and you jump off the wagon and race toward your young cousins.

Soon you are all sitting on the grass munching on freshly baked bread and freshly churned butter. As the buttered biscuit melts in your mouth you feel how lucky your cousins are to live here. Even though smoke is billowing from the furnace, the air smells of rotten eggs, and flies and wasps buzz about your head, the garden dirt feels good on your bare feet, the sun feels good on your upturned face and you are happy to be at Hopewell Furnace.

Name: _____

Hopewell Furnace Crossword Puzzle

Use the clues below to complete the crossword puzzle on the next page.

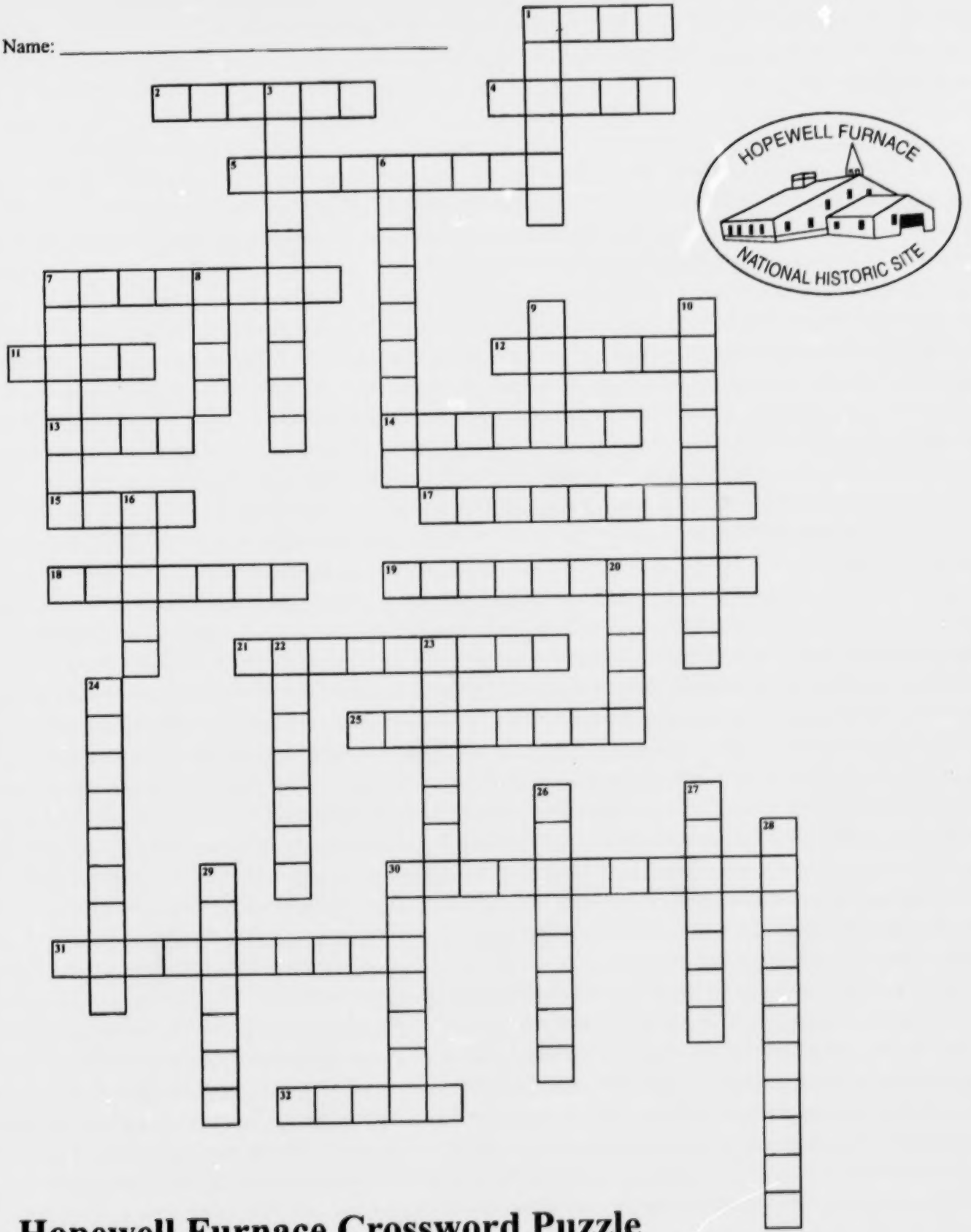
Across

1. The cleaning agent, which at Hopewell was limestone
2. The assistant who directs the furnace work when the founder is not present
4. The wooden frame used to hold sand in place when making cast products
5. The building where men work casting iron products (2 words)
7. The main fuel used at Hopewell
11. The waste product of the iron-making industry
12. The person who grows crops and tends animals
13. Comes from iron ore and is used to make pots, pans, and tools
14. The manager of the furnace operation whose job it is to make high-quality iron
15. The ditch that carries water to the water wheel
17. The person who removes stones from a quarry
18. The person who files off the rough edges of the cast iron products
19. The person who works, repairs, and shapes iron using an anvil and a hammer
21. A rock used as a flux at Hopewell
25. The person who drives a team of horses for hauling
30. The walkway between the top of the furnace and the charcoal shed (2 words)
31. A wheel turned by running or falling water in order to produce air
32. The period of time when a furnace is making iron

Down

1. The person who dumps charcoal, iron ore, and limestone into the furnace stack
3. A community where the owner and employees both work and live
6. A woman who manages a home and takes care of domestic affairs
7. The person who makes charcoal from wood
8. A unit of measure for cut wood
9. The servant employed to perform domestic duties
10. The owner of the furnace
16. The person who manages the company store and is the paymaster
20. A worker who removes ore from the earth
22. A rock which contains the metal iron (2 words)
23. The person who gives lessons to a student
24. The workman who prepares the gutters or channels in the sand floor of the cast house to make pig iron bars
26. Residence of the ironmaster (2 words)
27. The person who makes the molds used to cast products
28. The rented building where an employee lives (2 words)
29. A stone structure where iron is produced at a high temperature
30. A device for producing a stream of air under pressure

Name: _____



Hopewell Furnace Crossword Puzzle

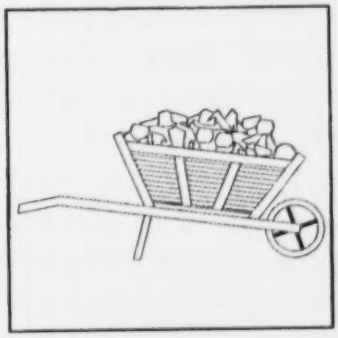
Name: *Answer Key*

Hopewell Furnace Crossword Puzzle

Name: _____

Hopewell Furnace Flow Chart

On the empty spaces below each picture, write what is needed or produced at that step.



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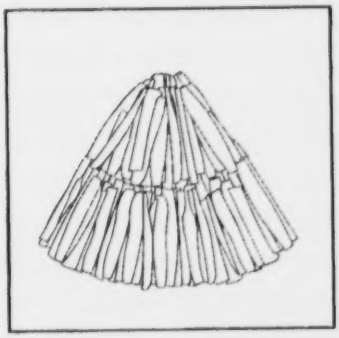

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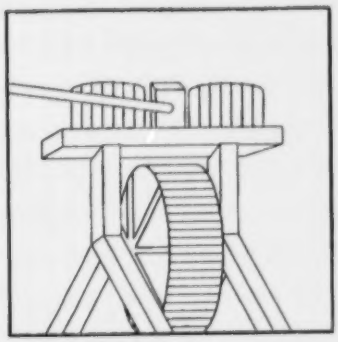

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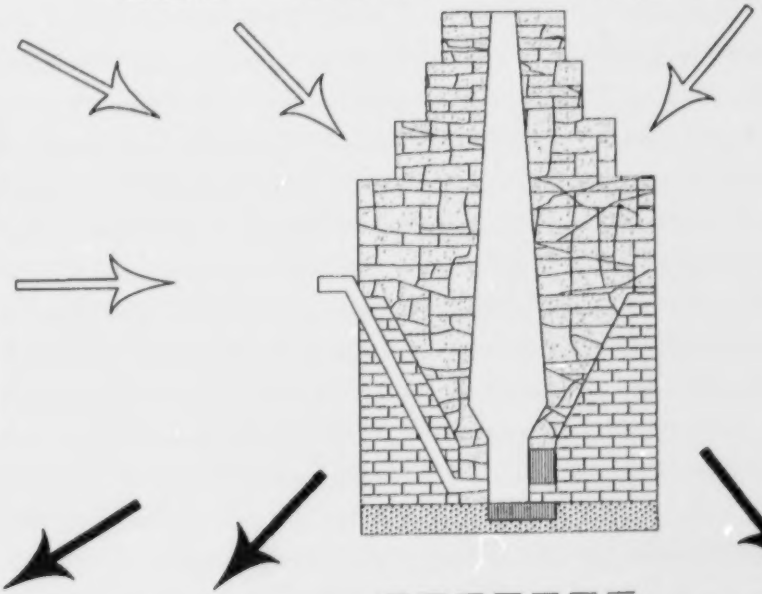

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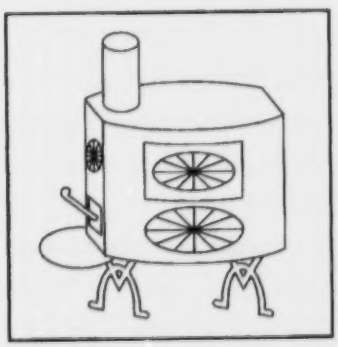

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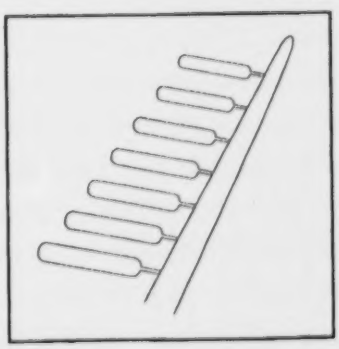

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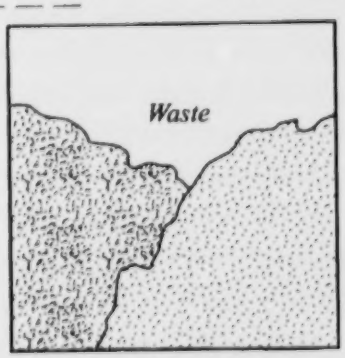

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Name: *Answer Key*

Hopewell Furnace Flow Chart

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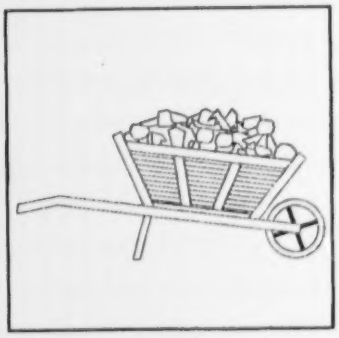

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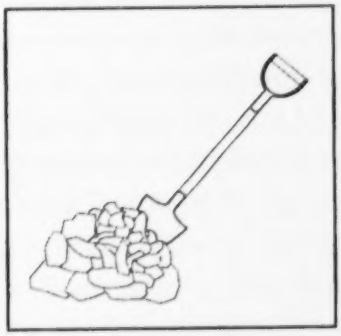

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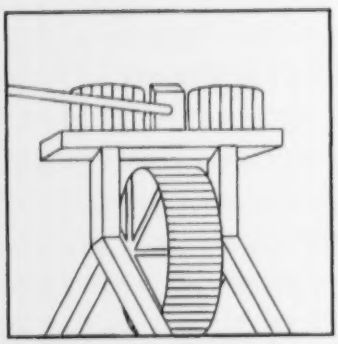

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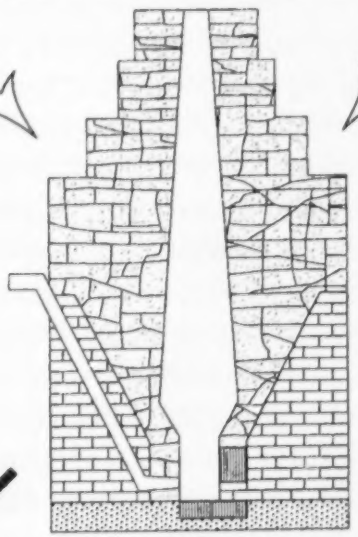

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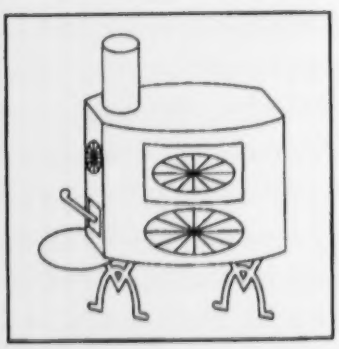

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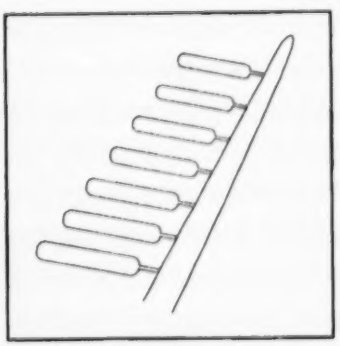
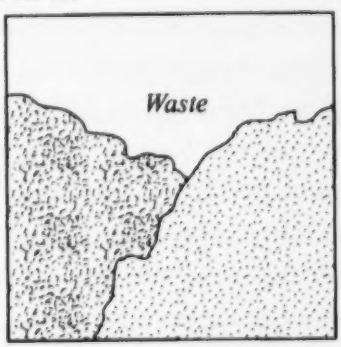
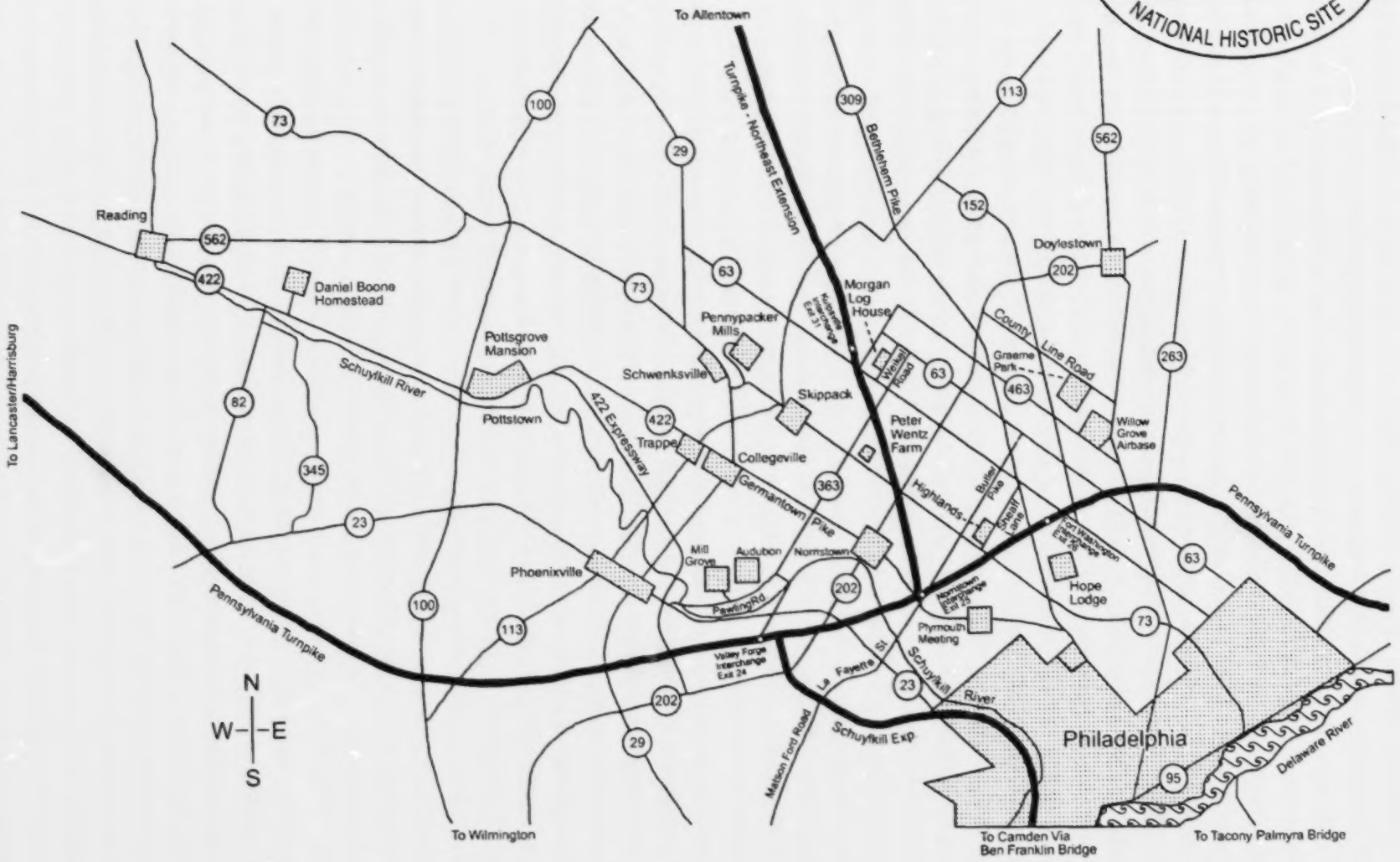


P I G S



S L A G

Hopewell Furnace Locator Map



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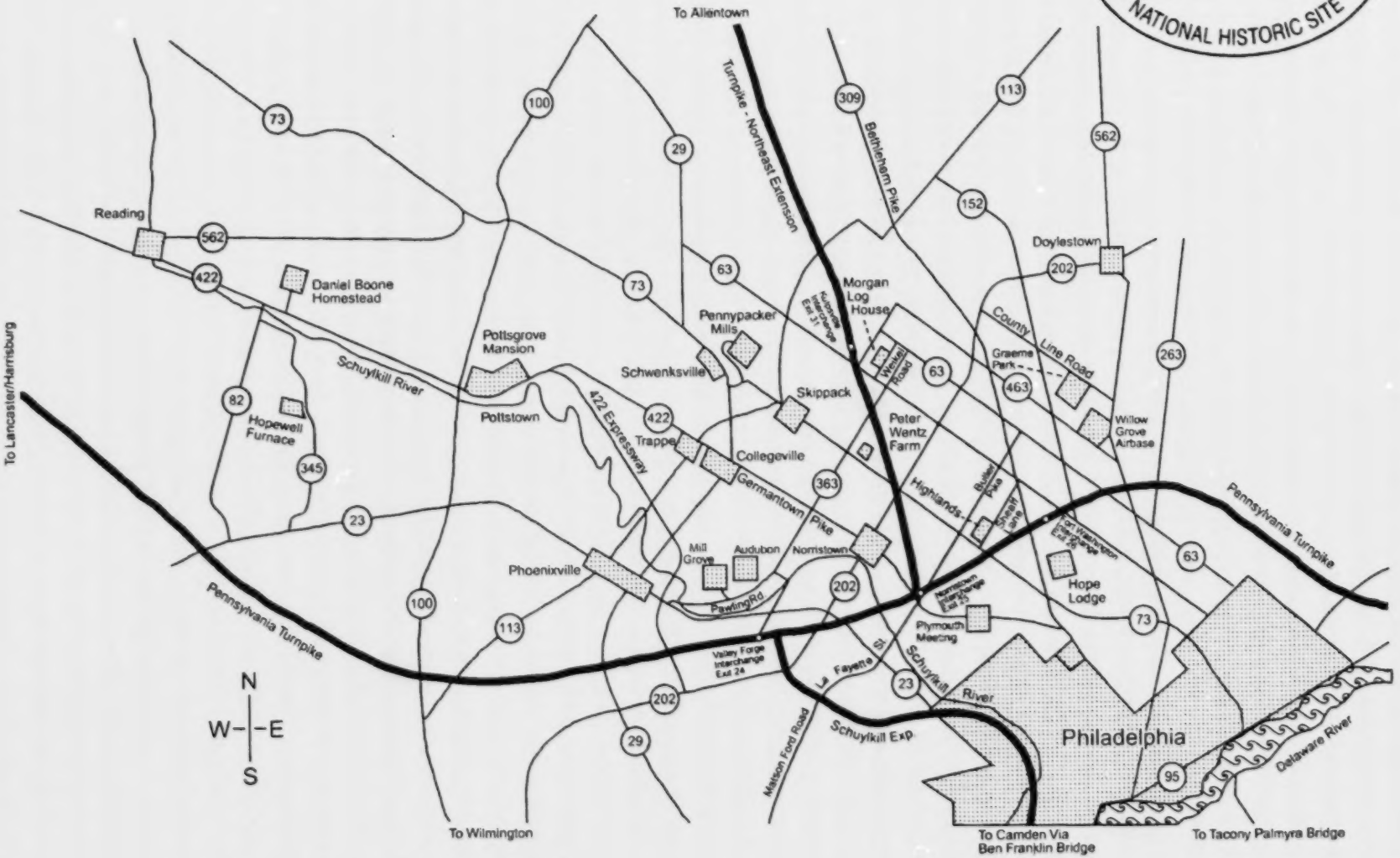
Hopewell Furnace Locator Map



Name: *Answer Key*

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Hopewell Furnace Vocabulary

This vocabulary list can be used to prepare the teacher and the students for the visit to Hopewell Furnace.

BELLOWS ..... A device for producing a stream of air under pressure; in iron-making this air provided the oxygen to keep the furnace fire burning and was contained in two large barrels called blowing tubs at Hopewell.

BIG HOUSE ..... Residence of the ironmaster or the manager of the iron furnace. It was referred to as the "Big House" in contrast to the small tenant houses where the workmen lived.

BLACKSMITH ..... Person who works, repairs and shapes iron using a forge, anvil, hammer, and other tools. A blacksmith was an important artisan in early America. At Hopewell, in addition to making horseshoes, nails, and hinges, he often had to make mechanical repairs to the furnace equipment.

BLAST ..... The period of time during which the furnace was in operation. "In blast" was the time the furnace was making iron. "Out of blast" was any period when it was not operating.

BLAST FURNACE ... A furnace where blasts of air are pumped into the fire to speed up the smelting process.

BRIDGE HOUSE .... The covered walkway between the charcoal house and the top of the furnace where the ingredients are placed into the chimney by the filler.

CAST HOUSE ..... The building in front of the furnace where men work at casting iron products.

CHARCOAL ..... The fuel used at Hopewell Furnace to melt the iron ore and limestone inside the furnace, made by burning wood in a very limited air supply. Charcoal was ideal fuel because it was almost free from sulfur and acted as part of the flux needed to smelt ore.

CLEANER ..... The person who files the rough edges off the cast iron products and also cleans the sand off the iron products before they are packed for shipment.

CLERK ..... Person who acts as business assistant to the ironmaster, manages the company store, keeps track of the iron company's business records, and is the paymaster.

COLLIER ..... A person who makes charcoal from wood; he often lived in the woods in a crude shelter, while he tended his charcoal pits.

CORD ..... A unit of measure for cut wood; a stack that measures 8 feet long, 4 feet high, and 4 feet deep.

FARMER ..... A person who manages a farm by growing crops and tending animals.

FILLER ..... The person with the dangerous job of filling the furnace stack with iron ore, charcoal, and limestone.

FLASK ..... The wooden frame used to hold sand in place when making cast products.

FLUX ..... This is a cleaning agent used in removing the impurities from an ore; limestone was used at Hopewell in iron ore smelting. When added to iron ore and heated, the flux mixes with the impurities in the ore and creates slag, leaving the metal (iron) behind.

FOUNDER..... The skilled manager of the furnace operation. He oversaw everything that went into and came out of the furnace. His job was to produce high-quality iron products.

FURNACE..... A stone structure where iron is produced at a high temperature (about 3000 ° F).

GUTTERMAN..... An unskilled workman at the furnace whose duty it is to remove slag and cinder from the work area. He also cast pig iron bars in the sand floor of the cast house.

HOUSEWIFE ..... A woman who manages a home and takes care of domestic affairs.

IRON ..... Comes from iron ore; used to make a variety of tools and products.

IRON ORE ..... A rock that is mined from the Earth and contains the metal iron.

IRONMASTER ..... The general manager of the furnace, usually the owner.

KEEPER..... The assistant to the founder. He directs the furnace work when the founder is not present.

LIMESTONE ..... A rock taken from quarries and used as flux during the smelting of iron ore at Hopewell.

MAID ..... A servant employed to perform domestic duties such as cleaning, cooking, and serving food.

MINER ..... A worker who removes a rock, mineral, or ore, such as iron ore, from the Earth.

MOULDER ..... A person who makes the molds used to cast products such as pots, pans, and stove parts.

PIG IRON..... Raw cast iron of uniform shape and size, usually a rough bar. These pig iron bars were formed by moulds in the sand floor of the cast house that resembled little pigs nursing on the belly of their sow. The pig iron bars were then sold to a forge or finery for further refinement into wrought iron or other fine cast products.

PLANTATION ..... A community where the owner and employees both work and live; at Hopewell it contained the furnace, shops, school, homes, fields, orchards, and other places.

QUARRYMAN ..... Person who works in a quarry removing stones such as limestone.

RACE ..... A ditch that carries water to or from the water wheel.

SLAG ..... The waste product of the iron making industry.

SMELTING..... The process by which iron is removed from iron ore.

TEACHER ..... A person who gives lessons to a student.

TEAMSTER..... A person who drives a team of horses, oxen, or mules for hauling.

TENANT HOUSE .... House owned by the ironmaster and rented by an employee.

WATERWHEEL ..... Large wheel turned by running or falling water; at Hopewell it pumped the bellows which produced the air blast for the furnace.

Name: _____

Hopewell Furnace Worker Identification

The next three pages will test your knowledge concerning workers at Hopewell Furnace in the 1800s. Match the following occupations with the pictures that show them.

- Blacksmith
- Collier
- Farmer
- Filler (used twice)
- Founder (used twice)
- Gutterman (used twice)
- Laborer
- Maid
- Miner
- Moulder (used twice)
- Teamster
- Woodcutter

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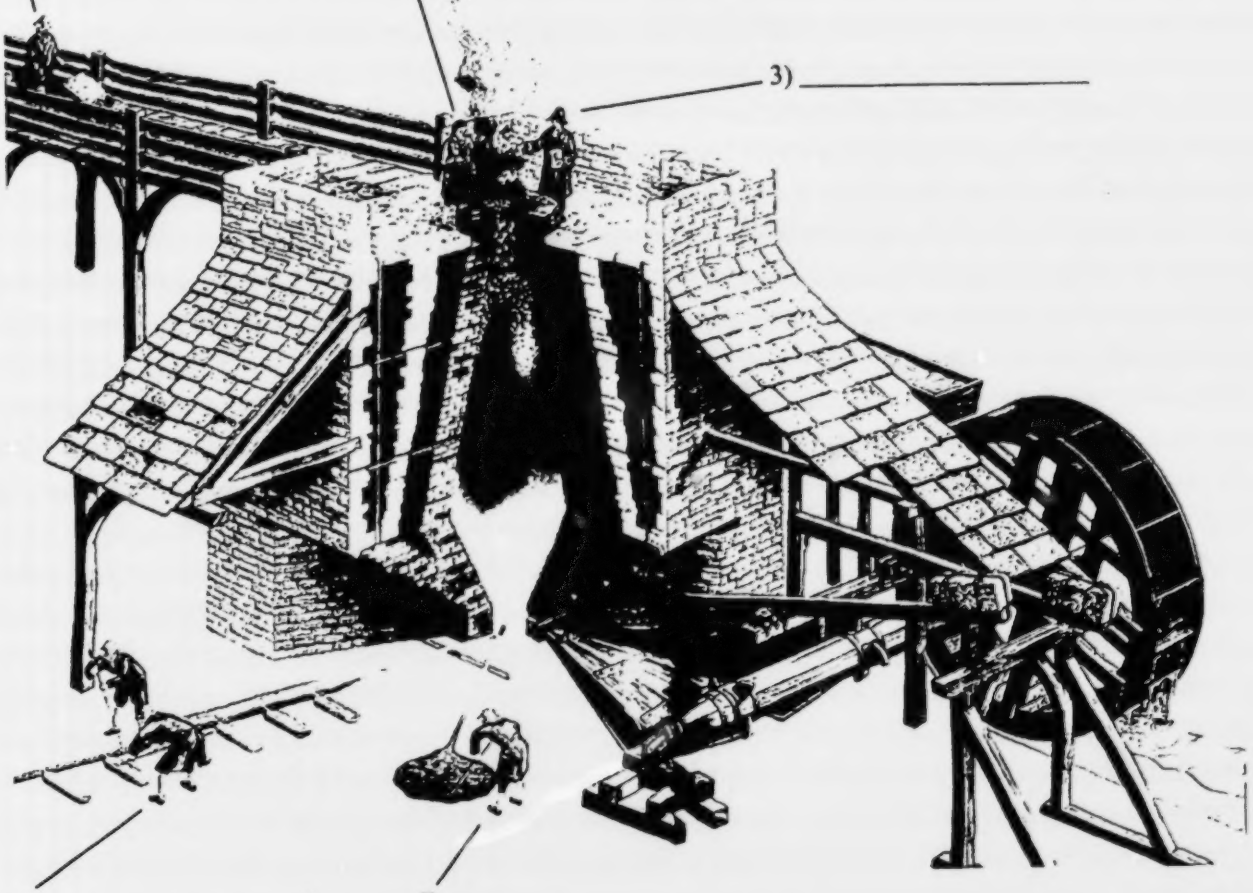
1) _____

2) _____

3) _____



4) _____

5) _____

Name: _____

6) _____

7) _____

8) _____

9) _____

10) _____

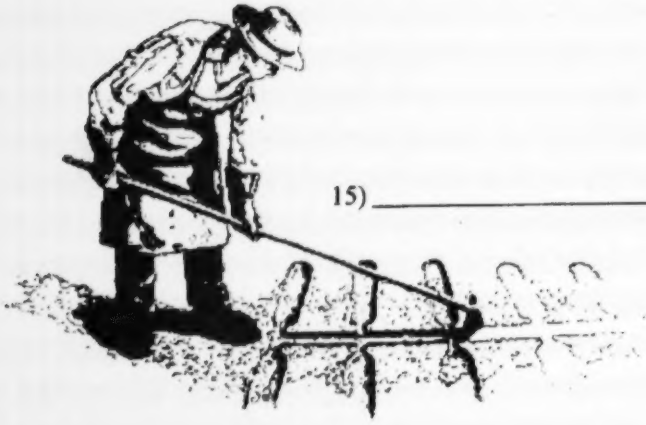
Name: _____

11) _____

12) _____

13) _____

14) _____



15) _____

16) _____

Hopewell Furnace Worker Identification

Answer Key

1) Filler
2) Laborer
3) Founder
4) Gutterman
5) Moulder
6) Founder
7) Filler
8) Woodcutter
9) Blacksmith
10) Collier
11) Moulder
12) Teamster
13) Miner
14) Farmer
15) Gutterman
16) Maid

The Iron-Making Process

The Ingredients

The four main ingredients for making iron were present in the area of Hopewell and were a reason for the furnace's location.

I. Wood
   - A. Used as a primary energy source in village operations
     1. As charcoal to power the furnace and blacksmith shop
     2. As fuel for heating and cooking
   - B. Used as building material for:
     1. Homes
     2. Wagons and equipment

II. Water
   - A. Used to turn the water wheel connected to the bellows which forced blasts of air into the furnace to increase the heat
   - B. Used for:
     1. Drinking
     2. Bathing
     3. Cooking
     4. Washing
     5. Cleaning

III. Iron Ore

Iron ore was dug from open-pit mines near Hopewell, then hauled to Hopewell Furnace in carts and wagons

IV. Limestone

Used as a "flux," which removed impurities from the ore as the iron ore was smelted; it was quarried near Morgantown and from Hopewell Plantation lands

The Process

This process was also called smelting.

I. In the furnace, the charcoal burns with a great amount of heat.

II. The water wheel was attached to a huge bellows and later to blowing tubs — like can be seen at Hopewell today — which blasted the charcoal with air to increase the heat.

III. The furnace was filled, or "charged," from the top in this order:
   - A. Fire
   - B. Charcoal

C. Iron Ore
D. Limestone
E. Charcoal
F. Iron Ore
G. The process continued and repeated as the ore melted

IV. When heated, limestone becomes gummy. It picks up the impurities and floats to the top of the molten iron. It acts as a cleaning agent. When cooled, the combination of impurities and limestone is called slag. [*Safety Note*: Hills of slag, a waste material, are still visible at the site. Slag is rough and sharp — it cuts skin easily! Students should be advised to stay away from slag piles.]

V. The heavy molten iron sinks to the bottom of the furnace.

VI. The molten iron collects there until the founder decides it is time to "tap" or drain off the furnace.

VII. The furnace was tapped approximately every twelve hours and the molten iron allowed to flow into trenches on the floor of the casting house. When cooled, these rough castings were bars of iron called "pigs." These pigs were then sent to forges to be forged or hammered into other iron products.

A. The name, "pigs," comes from the shape of the trenches which resemble a sow feeding her piglets.

1. The main trench is called the "sow"
2. The branch trenches are called "pigs"

B. Pig iron was Hopewell's principle product throughout its history

VIII. Molten iron was also poured into molds made of wet sand to make stove plates and a variety of other iron products.

A. During the 1830s, stoves were the most manufactured product at Hopewell Furnace — over 80,000 were made.

B. Other iron products were cast at Hopewell:

1. Pots
2. Irons
3. Ironstands
4. Hammers
5. Anvils
6. Dutch Ovens
7. Lids
8. Wheels
9. Baking Plates
10. Tea Kettles
11. Screws
12. Pans
13. Cannons
14. Prison Bars
15. Sash Weights
16. Clock Weights
17. Shot & Shell
18. Franklin Fireplaces

Iron Ore to Cast Iron Stove Parts

Please read and study this condensed story about the direct contributors to the iron-making process.

In order to perform the smelting process, which is the removal of iron from iron ore in a blast furnace, numerous individuals are required to execute specific tasks. The natural resources that are required for these workers to fulfill the process are **iron ore, limestone** (flux/cleaning agent), **charcoal** (fuel), and **water** (waterwheel power for air blast).

The Iron Ore: Mining iron ore from open-pit mines in the Hopewell area was done by **miners**. The ore was loaded on wagons which were generally pulled by draft horses; **teamsters** were the people that handled these horses and wagons. The load of iron ore was brought to the furnace area.

The Limestone: Limestone was the flux or cleaning agent that removed the impurities from the iron ore, thus allowing the iron to separate out of the ore. Limestone was quarried (type of mining) locally by the **quarrymen**. As with the iron ore, limestone was loaded on wagons and ushered to the furnace area by the teamsters.

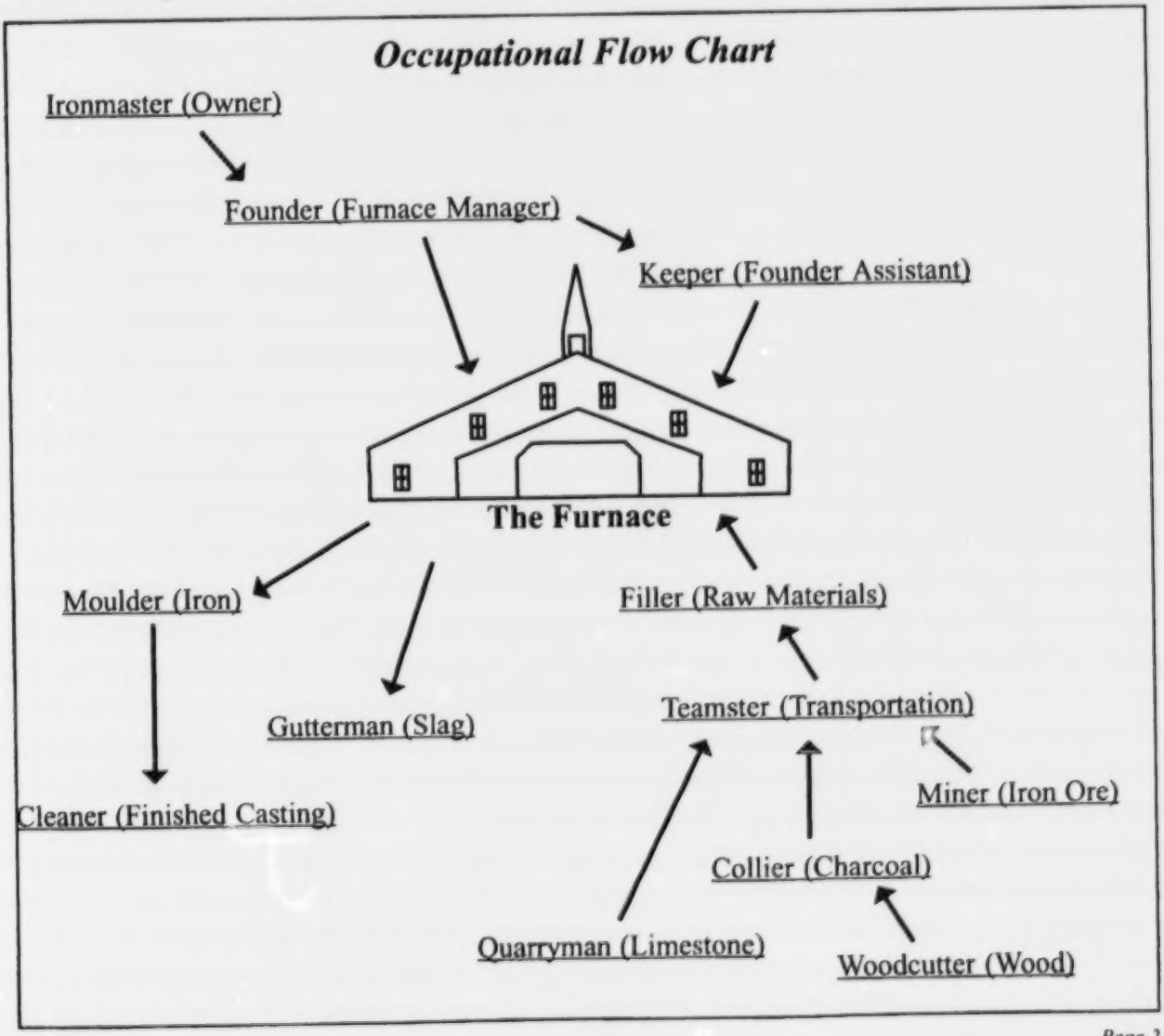
The Charcoal: In order to make charcoal, wood is needed. **Woodcutters** were hired to cut down trees so that those trees could be processed into charcoal. **Colliers** stacked wood, covered the wood with leaves and dirt, ignited the wood, and allowed the wood to smolder until all moisture and impurities were expelled, leaving only charcoal. A collier raked the cold charcoal from the pile, loaded it into the wagons, and the teamsters hauled it to the charcoal shed at Hopewell.

The Water: A waterwheel was needed to operate a huge "bellows" in order to produce the blasts of air required to burn the charcoal at maximum temperatures. The water that powered the waterwheel was brought from various sources via headraces (man-made waterways).

The Furnace: The **ironmaster** was the general manager of the furnace enterprise; usually he was the owner or a partner of the company. The ironmaster employed the **founder**; the founder was the highly skilled manager of the furnace operation. The founder's experience and knowledge were important factors in determining the quality of the iron that was produced. The assistant to the founder was the **keeper**. The keeper directed the furnace work when the founder was not present.

The Workers: Under the direction of the founder (or keeper) the semi-skilled **filler** would place the raw materials in the top of the furnace; as the filler placed the iron ore, limestone, and charcoal into the furnace, the blast (furnace operation) continued, sometimes for more than a year without stopping. When a 12 hour shift was complete, the furnace was tapped by the founder (or keeper). The molten iron that flowed was used by the skilled **moulders** to produce their cast iron products; excess molten iron was diverted into channels (called pigs) in the sandy floor by the **gutterman**. The gutterman was also responsible for removing and disposing of slag, the waste product of the furnace.

The Moulders: These skilled workers used wooden flasks, sand, and a pattern to produce a mold into which molten iron was poured to produce a cast iron product. The moulders got paid by the weight of the successfully produced casts only. Successful castings were then cleaned and prepared for shipment by the **cleaners**. Any defective castings were sold as scrap by the ironmaster.



Moulder's Apprentice Tour

Contents

- Moulder's Apprentice Tour -- Contents
- Moulder's Apprentice Tour -- Description and Objectives
- Fee Waivers for Educational Purposes
- Hopewell Furnace Vocabulary
- Hopewell Furnace Chronology
- Rules and Consequences
- Moulder's Apprentice Tour -- Pre- and Post-Visit Activities
- The Iron-Making Process
- Iron Ore to Cast Iron Stove Parts
- Pre-Visit Research Worksheet
- The Furnace, A Cold-Blast Smelting Operation
- Occupations at Hopewell During the 1830s
- Word Scramble
- True or False Activity
- Hopewell Furnace Worker Identification
- Post-Visit Review
- Evaluation Form

All materials in this packet are available online at www.nps.gov/hofu/teachers.

Duplication Consent: You may copy any part or page of this packet for use by the students, teachers and chaperones that will be attending this Hopewell educational tour.

Moulder's Apprentice Tour

Audience

3rd and 4th Grades

Description

A one hour tour that emphasizes the jobs people did during the 1830's at Hopewell leads to a hands-on mold-making experience by the students. The Molding/Casting lab will take about one and a half hours. The students will take a break to allow their molds to dry. The entire educational experience will run two and one half-hours.

Requirements

Class size for this tour will be kept to 25 students. It is required to have one chaperone per 10 students. Students must be made aware of the positive behavior that is expected during the tour and lab activities. Teachers are required to maintain the attention of the students; the Ranger is not responsible for discipline.

Theme

The molding and casting of iron products was the main thrust of Hopewell Furnace during its heyday in the 1830's. The Moulders were considered highly skilled and very valuable employees to the ironworks.

Hopewell Furnace Program Objectives

1. Visitors/students will understand how a number of the occupations were very demanding.
2. Visitors/students will understand many of the occupations that were important to the iron-making success of Hopewell.
3. Visitors/students will experience and learn the molding/casting process.
4. Visitors/students will understand some aspects of the educational process in the 1830's.

Related Objectives of Local Schools

1. Students will learn about a community of long ago.
2. Students will be able to identify a local historic landmark in their immediate area.
3. Students will learn about some of the skills needed by early Americans in order to do certain jobs.
4. Students will learn about industry after the American Revolution.
5. Students will learn the difference between a pattern and a mold and a cast.
6. Students will experience a job from the 19th century
7. Students will learn about the iron-making process.
8. Students will be exposed to an educational experience from the 19th century.
9. Students will understand some of the occupational hardships of the 19th century.
10. Students will understand the importance of working together to achieve common goals.
11. Students will learn about occupations of the past.
12. Students will learn about the value and dignity in working.
13. Students will compare tools from different time periods.
14. Students will understand the need for both natural and human resources in a community.
15. Students will learn some basic history about an iron-making plantation.

Molding and Casting Tour

Pre-Visit Activities

1. Show orientation and demonstration video on 19th Century occupations at Hopewell Furnace; includes charcoal making (colliers), molding / casting (moulders), and smithing (blacksmiths).
2. Students should look over the list of occupations at Hopewell in order to familiarize themselves with the terminology.
3. Students should read the "Iron Ore To Cast Iron Stove Parts" story; the teacher should review the occupations mentioned in the story with the students.
4. Students should read over the vocabulary list.
5. Students should read over "The Iron-Making Process."
6. The teacher should hang the photo sample page on the bulletin board.
7. The teacher should administer the "Pre-Visit Research Worksheet / Quiz" to the students.

Post-Visit Activities

1. Each student should prepare a fictional journal that describes one's life for a short time period during the early 1800s.
2. Students can draw scenes that depict life in the early 19th Century.
3. Students can read books and historical records of the time period around 1830.
4. A student can make clothing like that worn during the early 1800s.
5. Students could bring their parents or friends to Hopewell to experience the history they so enjoyed.
6. Some interested students could make models of buildings, wagons, or other aspects of the Hopewell Plantation.
7. Students could prepare and present a dramatic representation of life at Hopewell during its heyday.
8. Students could prepare poems or songs about life at Hopewell during the early 1800s.
9. Students could research the iron industry during the 19th Century.
10. Students could visit other pre-20th Century iron-making historic sites.

Moulders, Miners and Maids Tour

Contents

- Moulders, Miners and Maids: A Furnace Community -- Contents
- Moulders, Miners and Maids: A Furnace Community -- Description and Objectives
- Fee Waivers for Educational Purposes
- Hopewell Furnace Vocabulary
- Hopewell Furnace Chronology
- Rules and Consequences
- Moulders, Miners and Maids Tour -- Pre- and Post-Visit Activities
- The Iron-Making Process
- Iron Ore to Cast Iron Stove Parts
- Pre-Visit Research Worksheet
- Moulders, Miners, and Maids: A Furnace Community -- Historical Character List
- Word Scramble
- True or False Activity
- Hopewell Furnace Crossword Puzzle
- Hopewell Furnace in 1836: A Visualization Activity
- Hopewell Furnace Locator Map
- Hopewell Furnace Flow Chart
- Post-Visit Review
- Evaluation Form

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PARKS AS CLASSROOMS

Hopewell Furnace
National Historic Site
www.nps.gov/hofu

Teacher's Guide

Moulders, Miners and Maids

A Furnace Community

AUDIENCE

3rd through 6th Grades

DESCRIPTION

A two-hour participatory tour that emphasizes the furnace community. Every student (maximum one class/30 students or minimum 18 students) will be assigned roles they will play in the tour. These assignments must be made prior to coming to the park. Teachers and chaperones should not be assigned roles unless it is necessary to make the required number of 18. For the tour, each participant will wear an article of clothing representative of his or her role. Each will also receive a haversack (shoulder bag) containing an object that may be passed to another participant during the tour. The ranger/interpreter will also be in costume while leading the tour.

REQUIREMENTS

Class size for this tour will be kept to 30 students. A minimum of 18 students is needed for this program. It is required to have one chaperone per 10 students. Students must be made aware of the positive behavior that is expected during the tour. Teachers are required to maintain the attention of the students; the Ranger is not responsible for discipline.

THEME

Hopewell Furnace illustrates the change from agricultural self-sufficiency to industrial specialization and increased interdependence in the new United States.

HOPEWELL FURNACE PROGRAM OBJECTIVES

1. Students will relate 1830's industrial life to agricultural life.
2. Students will describe several jobs necessary to make the community function.
3. Students will chart the flow of the natural resources in the process of making iron.
4. Students will describe the process of iron-making in general terms.
5. Students will list two ethnic groups represented in Hopewell's workforce.

RELATED OJECTIVES OF LOCAL SCHOOLS

1. Students will learn about a community of long ago.
2. Students will be able to identify a local historic landmark in their immediate area using a map.
3. Students will learn about some of the skills needed by early Americans in order to do certain jobs.
4. Students will learn how communities have different areas known as industrial, commercial, residential and recreational.
5. Students will learn that communities need both natural and human resources.
6. Students will experience a job from the 19th century and recognize differences among people.
7. Students will learn about the iron-making process.
8. Students will recognize some of the industries in the Berks, Chester, and Montgomery County region.
9. Students will understand some of the occupational hardships of the 19th century.
10. Students will understand the importance of working together to achieve common goals.
11. Students will learn about occupations of the past.
12. Students will learn about the value and dignity in working.
13. Students will learn some basic social history about an iron-making community

Moulders, Miners, and Maids: A Furnace Community

Historical Character List

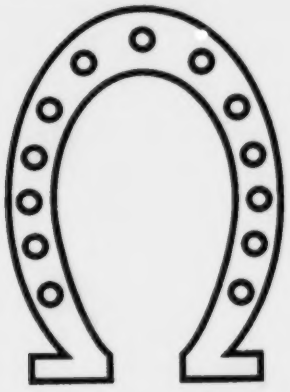
Characters must be assigned to students prior to coming to Hopewell Furnace NHS. Nametags should list the student's name and character and always be visible to the tour guide. The first 18 characters are essential to have the program. Characters should only be given to students. Chaperones may take character roles only if there are fewer students than the required number of 18. Chaperones are asked not to answer questions for the students or become involved in the tour unless asked by the tour guide. Chaperones must keep the students with the tour guide at all times. The tour moves quickly between each stop and it is imperative that the group stays together.

	Character	Traditional Gender	Nametag Pattern	Assigned to
1)	Woodcutter #1	either	tree	
2)	Collier #1	either	tree	
3)	Teamster #1	male	horseshoe	
4)	Miner	male	shovel	
5)	Quarryman	male	shovel	
6)	Gutterman	male	furnace	
7)	Filler	male	wheelbarrow	
8)	Founder	male	furnace	
9)	Moulder #1	male	furnace	
10)	Cleaner	either	furnace	
11)	Clerk	male	top hat	
12)	Blacksmith	male	horseshoe	
13)	Housewife	female	skillet	
14)	Farmer	male	sheep	
15)	Merchant	male	top hat	
16)	Maid #1	female	skillet	
17)	Ironmaster	male	top hat	
18)	Teacher	either	book	
19)	Laborer	either	shovel	
20)	Ironmaster's wife	female	book	
21)	Farmer's wife	female	sheep	
22)	Weaver	either	sheep	
23)	Maid #2	female	skillet	
24)	Collier #3	either	tree	
25)	Woodcutter #2	either	tree	
26)	Woodcutter #3	male	tree	
27)	Moulder #2	male	furnace	
28)	Moulder #3	male	furnace	
29)	Teamster #2	male	horseshoe	
30)	Teamster #3	male	horseshoe	
31)	Keeper	male	furnace	
32)	Blacksmith Helper	male	furnace	

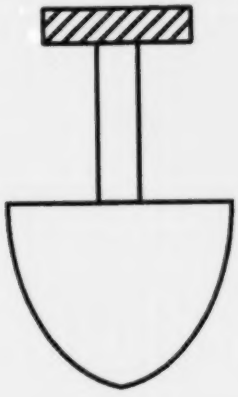
Characters may be assigned to any student and need not follow historical genders. Please assign only one student per character, or one student per line, up to 32 students. Example: There may be 3 Teamsters, but only one housewife.

Tree -- Woodcutter, Collier

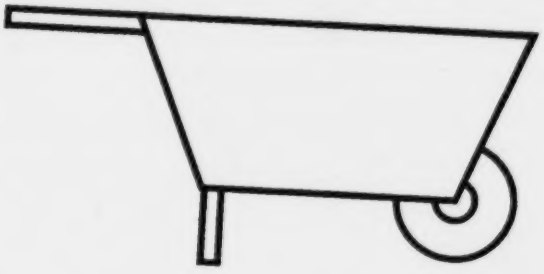
Horseshoe -- Teamster, Blacksmith



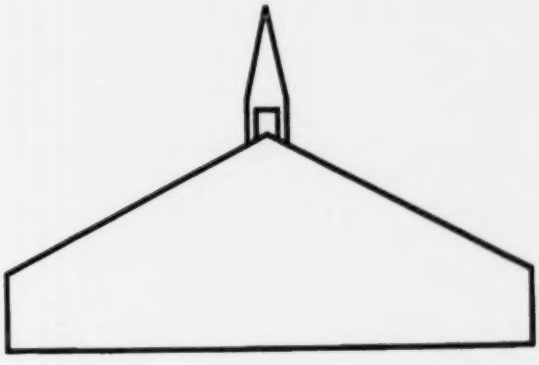
Shovel -- Miner, Quarryman, Laborer



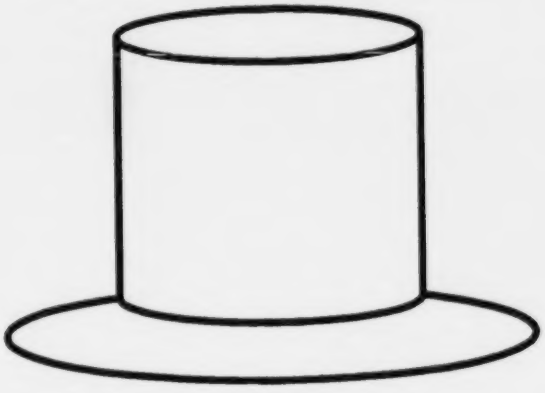
Wheelbarrow -- Filler



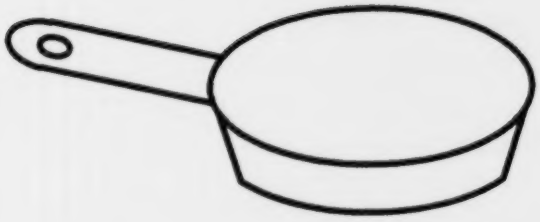
Furnace -- Founder, Moulder, Cleaner, Gutterman



Top Hat -- Clerk, Merchant, Ironmaster

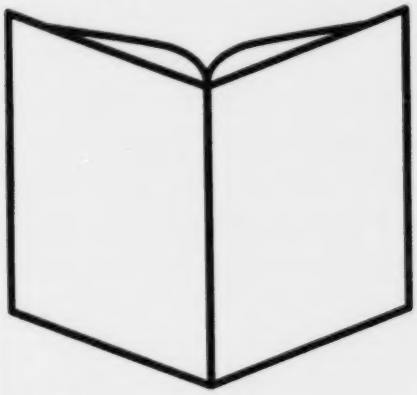


Skillet -- Housewife, Maid



Sheep -- Farmer, Farmer's Wife, Weaver

Book -- Ironmaster's Wife, Teacher



Moulders, Miners and Maids Tour

Pre-Visit Activities

1. View the park video of the orientation program and demonstrations segments.
2. Assign roles to students.
3. Make name tags of the roles for each student.
4. Discuss the description of the blast furnace operation.
5. Locate Hopewell Furnace on the map and discuss other industries in the area, past and present.
6. Complete any pre-visit activities such as the crossword puzzle and true and false activity.
7. Discuss Glossary of Terms.
8. Discuss Hopewell Furnace, a part of the National Park Service, as elements of the national/local community.

Post-Visit Activities

1. Draw a flow chart of the making of pig iron.
2. Draw a flow chart of the jobs required to make pig iron, up to the gutterman and moulder.
3. Discuss what would happen if some of the roles were missing, perhaps through an accident or illness; could the community still function well?
4. Write a letter from your character to a friend in another state describing your work at Hopewell Furnace and who cooperates with you to get the job done.
5. Discuss the functions of a park ranger and the importance of preserving historical sites in the community.
6. Complete program evaluation form and return it to the park.

Occupations at Hopewell During the 1830s

(listed below in no particular order)

The teacher should become acquainted with these 19th century Hopewell occupations so that the students can be better prepared for their Hopewell Furnace experience.

Generally Women

- cooking for workers
- spinning / selling yarn
- mending / sewing for others
- candle / soap making
- public school teaching
- private tutoring
- grow / sell food stuffs
- maid activities
- housekeeping
- various farm tasks
- cleaning casts
- farm operators
- casting wholesalers
- white-washing / painting
- occasional mining
- occasional wood cutting
- investors
- weavers / sell products
- occasional charcoal making

Generally Men

- woodcutter
- collier
- moulder
- founder
- filler
- gutterman
- farm worker
- ironmaster
- keeper
- clerk
- gardener
- houseworker
- box maker
- miner
- moulder's helper
- pattern-maker
- minister
- blacksmith
- teamster
- wheelwright
- quarryman
- tutor / teacher
- mason

Name: _____

Post-Visit Review

Use the information supplied in the teacher's guide, along with the ideas learned during the tour and hands-on experience at Hopewell Furnace, to answer these questions.

You go to a beach full of beautiful sand for a picnic. While you are there you notice that you are leaving footprints in the sand. (circle the correct answer)

1. Is your foot considered a MOLD, a CAST, or a PATTERN?

2. If you were to pour plaster-of-paris into the footprint and let it harden, would the plaster-of-paris foot be considered a MOLD, a CAST, or a PATTERN?

3. Is your original footprint considered a MOLD, a CAST, or a PATTERN?

The following questions concern jobs at Hopewell Furnace in the 1800s. Here are the possible answers: filler, gutterman, moulder, miner, quarryman, collier, keeper, ironmaster, or maid.

4. The _____ was the supervisor, and usually owner, of the furnace.

5. _____ used shovels to remove the iron ore from the earth.

6. A _____ was the skilled person who made charcoal from wood.

7. The _____ was the foreman and was in charge of the furnace operation. He carried out the orders of the ironmaster. His assistant was called the keeper.

8. A _____ was usually a woman who was in charge of doing household duties for another person.

9. Workers who dug the limestone from quarries were called _____.

10. _____ made sand molds from patterns and then poured molten iron into the molds to produce cast iron products.

Name: _____ *Answer Key* _____

Post-Visit Review

Use the information supplied in the teacher's guide, along with the ideas learned during the tour and hands-on experience at Hopewell Furnace, to answer these questions.

You go to a beach full of beautiful sand for a picnic. While you are there you notice that you are leaving footprints in the sand. (circle the correct answer)

1. Is your foot considered a MOLD, a CAST, or a (PATTERN)?

2. If you were to pour plaster-of-paris into the footprint and let it harden, would the plaster-of-paris foot be considered a MOLD, a (CAST), or a PATTERN?

3. Is your original footprint considered a (MOLD), a CAST, or a PATTERN?

The following questions concern jobs at Hopewell Furnace in the 1800s. Here are the possible answers: filler, gutterman, moulder, miner, quarryman, collier, keeper, ironmaster, or maid.

4. The _____ *Ironmaster* _____ was the supervisor, and usually owner, of the furnace.

5. _____ *Miner* _____ used shovels to remove the iron ore from the earth.

6. A _____ *Collier* _____ was the skilled person who made charcoal from wood.

7. The _____ *Founder* _____ was the foreman and was in charge of the furnace operation. He carried out the orders of the ironmaster. His assistant was called the keeper.

8. A _____ *Maid* _____ was usually a woman who was in charge of doing household duties for another person.

9. Workers who dug the limestone from quarries were called _____ *Quarryman* _____.

10. _____ *Moulder* _____ made sand molds from patterns and then poured molten iron into the molds to produce cast iron products.

Name: _____

Post-Visit Test

Answer the following questions:

1. _____ What is the name applied to the object that is used to make an impression in the sand, thus giving us a mold of that object?

2. _____ What is the name of the person who is in charge of making charcoal?

3. _____ What is the name of the flat board that was used to support the sand inside the flask as you flip the entire unit upside down?

4. _____ What name is applied to the tool that supplies an air blast when it is compressed?

5. _____ Who is the person that dumps the raw material into the top of the furnace so that the smelting process continues?

6. _____ What do we call the person who manages a farm by growing crops and tending animals?

7. _____ When a mold is made from a pattern and a liquid is poured into the mold and hardens, the resulting product is called by what term?

8. _____ What is the name of the person who makes molds from patterns?

9. _____ What term is used to describe wood that has been heated in the near-absence of air with an end product of burnable carbon?

10. _____ The ironmaster hired a founder to run the iron furnace; who was the first assistant to the founder?

Possible Answers

- Ironmaster
- Founder
- Keeper
- Moulder
- Gutterman
- Filler
- Miner
- Quarryman
- Collier
- Fallow Board
- Flask
- Molder's Spoon
- Riddle
- Cope
- Drag
- Mold
- Pattern
- Cast
- Bellows
- Farmer
- Charcoal
- Iron Ore
- Limestone
- Water
- Waterwheel

Name: *Answer Key*

Post-Visit Test

Answer the following questions:

1. *Pattern* — What is the name applied to the object that is used to make an impression in the sand, thus giving us a mold of that object?

2. *Collier* — What is the name of the person who is in charge of making charcoal?

3. *Fallow Board* — What is the name of the flat board that was used to support the sand inside the flask as you flip the entire unit upside down?

4. *Bellows* — What name is applied to the tool that supplies an air blast when it is compressed?

5. *Filler* — Who is the person that dumps the raw material into the top of the furnace so that the smelting process continues?

6. *Farmer* — What do we call the person who manages a farm by growing crops and tending animals?

7. *Cast (Casting)* — When a mold is made from a pattern and a liquid is poured into the mold and hardens, the resulting product is called by what term?

8. *Moulder* — What is the name of the person who makes molds from patterns?

9. *Charcoal* — What term is used to describe wood that has been heated in the near-absence of air with an end product of burnable carbon?

10. *Keeper* — The ironmaster hired a founder to run the iron furnace; who was the first assistant to the founder?

Possible Answers

- Ironmaster
- Founder
- Keeper
- Moulder
- Gutterman
- Filler
- Miner
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- Drag
- Mold
- Pattern
- Cast
- Bellows
- Farmer
- Charcoal
- Iron Ore
- Limestone
- Water
- Waterwheel

Name: _____

Pre-Visit Research Worksheet

Using the following information sheets, find the answers to these Hopewell Furnace questions: Occupations at Hopewell, Iron Ore to Cast Iron, Vocabulary, and The Iron-Making Process.

1. _____ Which gender was most likely to have the lesser chance at a highly skilled position at Hopewell during the 19th Century?

2. _____ Woodcutters supplied cut and split wood to the men who made the charcoal. What name was a charcoal maker known by?

3. _____ Who was the general manager and often the owner of the furnace?

4. _____ Charcoal, iron ore, limestone, people, and what other resource were needed to produce iron at Hopewell in the 19th Century?

5. _____ Who was the founder's primary assistant?

6. _____ Name applied to the waste product of smelting, made up of limestone and impurities from iron ore?

7. _____ Horses and wagons were the business of what person?

8. _____ What is the mineral that was the cleaning agent or "flux" in the iron-producing process?

9. _____ Who was the skilled person that repaired iron products, made kitchen utensils, produced horseshoes, and shaped many other needed iron products at Hopewell?

10. _____ Who used a wooden flask, sand, and a pattern to produce a mold for the making of a cast iron product?

Unscramble these letters to produce a term relating to the 1800's iron industry:

11. _____ ROACHCAL

12. _____ LIFERL

13. _____ ROUNDFE

14. _____ GLAS

15. _____ WELLSOB

Name: *Answer Key*

Pre-Visit Research Worksheet

Using the following information sheets, find the answers to these Hopewell Furnace questions: Occupations at Hopewell, Iron Ore to Cast Iron, Vocabulary, and The Iron-Making Process.

1. *Female* — Which gender was most likely to have the lesser chance at a highly skilled position at Hopewell during the 19th Century?

2. *Collier* — Woodcutters supplied cut and split wood to the men who made the charcoal. What name was a charcoal maker known by?

3. *Ironmaster* — Who was the general manager and often the owner of the furnace?

4. *Water* — Charcoal, iron ore, limestone, people, and what other resource were needed to produce iron at Hopewell in the 19th Century?

5. *Keeper* — Who was the founder's primary assistant?

6. *Slag* — Name applied to the waste product of smelting, made up of limestone and impurities from iron ore?

7. *Teamster* — Horses and wagons were the business of what person?

8. *Limestone* — What is the mineral that was the cleaning agent or "flux" in the iron-producing process?

9. *Blacksmith (Smith)* — Who was the skilled person that repaired iron products, made kitchen utensils, produced horseshoes, and shaped many other needed iron products at Hopewell?

10. *Moulder* — Who used a wooden flask, sand, and a pattern to produce a mold for the making of a cast iron product?

Unscramble these letters to produce a term relating to the 1800's iron industry:

11. *Charcoal* ROACHCAL

12. *Filler* LIFERL

13. *Founder* ROUNDFE

14. *Slag* GLAS

15. *Bellows* WELLSOB

Rules and Consequences

In order to have the best visit possible, we need your help. *Please discuss the following rules and consequences with your class before your visit.* Remind them it is a privilege to have a special group program.

Rules:

1. Always "think and act safely." Be on your best behavior. Do NOT run or climb on anything. Follow behind the ranger at a safe distance as you walk through the village.
2. Listen silently. Only one person can speak and be heard at a time.
3. Keep your actions and words from bothering others. Keep your hands and your things to yourself.
4. Take Pride in America. Keep the grounds and the buildings clean; do not litter.
5. Souvenirs may be purchased at the visitor center. Do not take slag, ore, charcoal, artifacts, rocks or anything else.

Consequences:

First Offense:	A verbal warning will be given.
Second Offense:	Disruptive students will be removed from the activity, but will be allowed to watch silently.
Third Offense:	Disruptive students will be removed from the rest of the group and wait with adult supervision on the bus.

Inappropriate behavior by the class overall, including disruptive noise or littering, will result in the activity being discontinued and a letter will be sent to the sponsoring school or organization detailing the problem.

The teacher or ranger may skip the first and/or second steps in case of a severe disciplinary problem.

TEACHERS AND ADULT CHAPERONES are expected to enforce these regulations and all activities of the group while in the park. Rangers are not expected to correct behavior problems.

Thank you for your cooperation.

Self-Guided Tour

Contents

- Self-Guided Tour -- Contents
- Self-Guided Tour -- Description
- Fee Waivers for Educational Purposes
- Hopewell Furnace Vocabulary
- Hopewell Furnace Chronology
- Rules and Consequences
- The Iron-Making Process
- Iron Ore to Cast Iron Stove Parts
- Pre-Visit Research Worksheet
- Hopewell Furnace in 1836: A Visualization Activity
- Self-Guided Tour -- "A Walk Back Into History"
- Word Scramble
- True or False Activity
- Post-Visit Review
- Evaluation Form

All materials in this packet are available online at www.nps.gov/hofu/teachers.

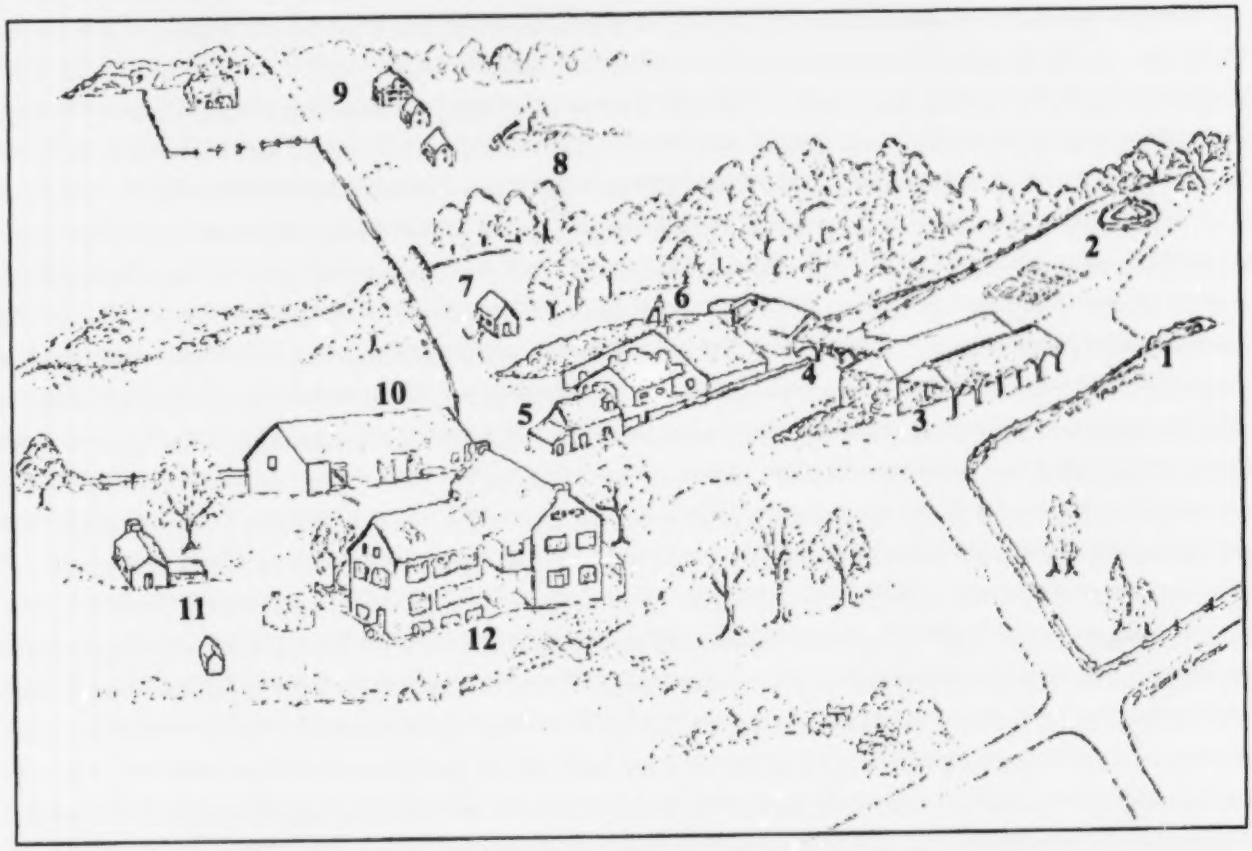
Duplication Consent: You may copy any part or page of this packet for use by the students, teachers and chaperones that will be attending this Hopewell educational tour.

PARKS AS CLASSROOMS™

Teacher's Guide

Map of Hopewell Furnace National Historic Site

Numbers correspond to those in "A Walk Back Into History"



1) Anthracite Furnace
2) Charcoal Hearth, Collier Hut and Charcoal Kilns
3) Charcoal House and Shed
4) Connecting Shed and Bridge House
5) Office — Store
6) Cast House and Furnace Stack
7) Blacksmith Shop
8) School House Ruins
9) Tenant Houses and Boarding House
10) The Barn
11) Springhouse and Smokehouse
12) Ironmaster's Mansion

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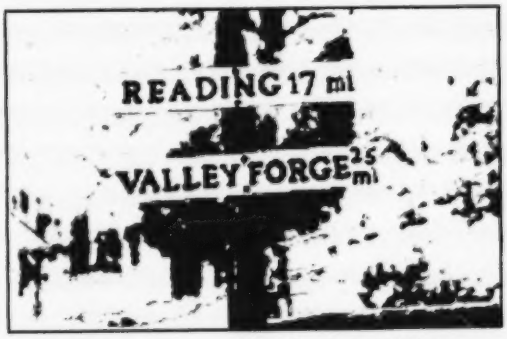
A Walk Back Into History

Use the map in the Hopewell Furnace National Historic Site brochure as a guide to this exercise. The different buildings and areas are numbered on the map. Find the text that describes each place.

Valley Forge — Reading Road



Valley Forge — Reading Road Sign

The roadway overlooking the furnace was built in 1757. During the early years of Hopewell's history, the iron made at the furnace was sent east by wagon along this road on a three-day journey to Philadelphia. After 1825 it also connected the furnace with the Schuylkill Canal. With the opening of the canal — and later, the building of the Reading Railroad — wagon trips were much shorter.

Take a left down the old Warwick-Birdsboro road into the historic site. If you walked this road two hundred years ago, how many people and wagons do you imagine would pass you going to and from Hopewell?

Anthracite Furnace (1)

Anthracite Furnace Ruins

This is the owners' attempt to modernize Hopewell's ironmaking operations. This hot-blast furnace employed a more modern method for ironmaking, using anthracite coal and a blast of pre-heated air. This process produced more iron and would eventually drive cold-blast furnaces like Hopewell out of business. The ironmaster at Hopewell hoped this new furnace would make better iron and increase profits. Unfortunately, it actually lost money for the furnace. Anthracite coal was expensive to ship by canals from distant mines to Hopewell Furnace. Transportation costs, plus the poor quality of the ore, and possibly structural defects contributed to its failure around 1855.

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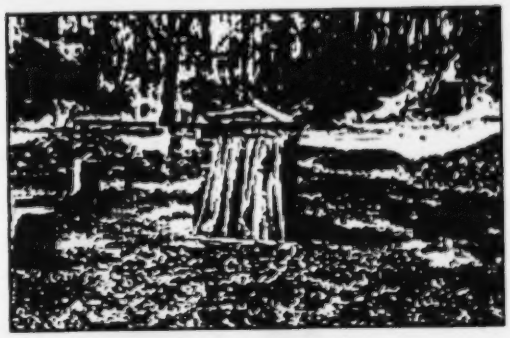
Charcoal Hearth, Collier Hut and Charcoal Kilns (2)



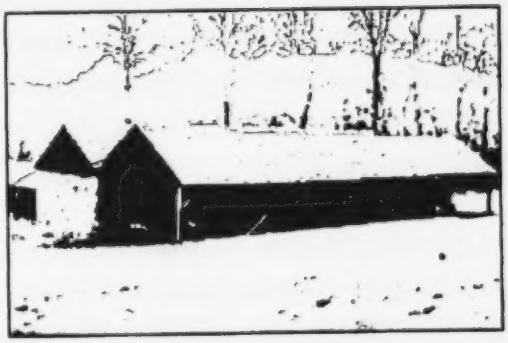
Charcoal Hearth

The cleared out, circular area (now covered with pieces of charcoal and ashes) is called a charcoal hearth. In the woods — on hearths like this — colliers (charcoal makers) produced the charcoal needed to fuel the furnace. Wood was piled in large mounds and covered with leaves and dirt so the wood burned slowly. It took about one acre of hardwood to operate the furnace for a day.

The small hut behind the hearth is the type built by colliers to live in while tending several hearths. This one is a replica of an earlier hut.

Next to the charcoal hearth are ruins of the charcoal kilns which were another effort to modernize production and reduce the number of workers needed at the furnace. They operated like an oven for making charcoal and could have been used year-round, but it was soon discovered that bringing the wood to the kilns was more expensive than taking the charcoal out of the woods. The ironmaster then converted the kilns into houses for the workers.

Charcoal House and Shed (3)



Charcoal House

For charcoal to burn properly, it was important to keep it dry. Charcoal was hauled by teamsters into this shed and dumped by pulling out the bottom boards of the wagons. After the charcoal had a chance to cool down completely, it was shoveled through the big windows into the charcoal house. When the house was filled to the roof, there was enough charcoal to fuel the furnace for six months.

At one end of the charcoal house is the ore pile. Miners dug the iron ore used at Hopewell from at least three different mines. Miners used simple tools like picks and shovels to remove the ore from open pits. Sometimes black powder was used for blasting the harder rock.

At the other end of the charcoal house (toward the charcoal hearth) is a pile of limestone. Limestone was the

purifying agent, also called the flux. Limestone, when heated at 3000 degrees Fahrenheit, combined with the impurities in the iron ore and formed "slag," a waste product. Iron, in a nearly pure form, separated from the slag and sank to the bottom of the furnace, while the slag floated on a layer above the iron.

Connecting Shed and Bridge House (4)

Connecting Shed and Bridge House

The covered passageway going from the charcoal house to the bridge house is called the connecting shed. This is where men called fillers worked. Their job was to fill the furnace with the "charge." A charge was made up of iron ore, charcoal and limestone. The limestone, also called "flux," combined with the impurities in iron ore and formed "slag," a waste product. Like most Hopewell workers, fillers worked twelve hours a day, on either a day or a night shift. Using wheelbarrows and carts, every half hour the fillers would dump approximately 300-400 pounds of iron ore, 30-40 pounds of limestone, and 15 bushels of charcoal into the top of the furnace, called the "tunnel head." Temperatures inside the furnace reached 3000 degrees Fahrenheit and high flames with clouds of smoke and gases would shoot up from the furnace stack, making the filler's job one of the most dangerous ones at the furnace.

Office — Store (5)

Office-Store

Workers were not required to buy at the store, but it was convenient and prices were similar to other stores. The company clerk worked here, keeping account of the orders, production, and transportation of the products made at Hopewell. He kept written accounts of all transactions in large books called "ledgers" and "journals."

The clerk was also the paymaster, but workers were not paid with cash. Instead, the clerk recorded in the ledgers the amount of money each worker earned. When an employee needed cash or store goods, he would go to the clerk and draw

on his account. Earnings by women and children were credited to the account of their husbands or fathers.

The people in the community at Hopewell had little time, opportunity or transportation to travel to other towns to shop. For this reason, the furnace ran a company store stocked with many of the things the workers needed, including the latest goods from Philadelphia and other cities.

Cast House and Furnace Stack (6)

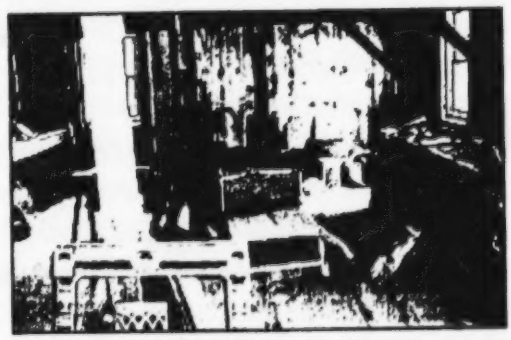
Cast House

The cast house was built around the furnace — the large stone chimney. When the furnace's bottom part, or "crucible," was filled with molten iron, the furnace workers would empty it. This was done two times a day and was called "tapping." The iron that came out of the furnace was molded into pig iron bars or into the many iron products cast at the furnace.

When the founder decided the furnace was ready to tap, a gutterman punched out a clay plug in the taphole of the dam stone at the base of the furnace. Red-hot iron ran out into a trench dug into the soft sand floor. From this main trench branched smaller channels. The cooled iron from these floor castings are called pigs — because the iron bars resemble a sow (a female pig) with piglets feeding beside her. Most of the pig iron from Hopewell was sold to forges where it was processed into bars and rods of wrought iron.

Up to the 1840s, much of Hopewell's iron was cast directly into stove plates, pots, skillets, anvils, and waffle irons. These products were cast in sand molds contained in wooden frames called flasks into which the molten iron was poured. The flask was placed on a bench by a moulder and a wooden pattern of the iron casting to be made was placed in the flask. Next the moulder covered the pattern with sand and turned the flask over. A second flask was placed on the first and filled with sand. The sand was packed in with a rammer. The moulder then would skillfully separate the two flasks and remove the pattern. One mistake and the mold would be ruined.

After the pattern was removed, the flask was put back together. When the furnace was tapped, the moulder would fill ladles with the molten iron and pour it into the flask through the "gate," a hole in the sand. Once the iron was cool, the flasks were taken apart and the casting removed. If the moulder had done a good job, the casting would look exactly like the pattern. When Hopewell was at its peak, there were fourteen to sixteen moulders working each day.



Inside of Cleaning Shed

Cleaning Shed

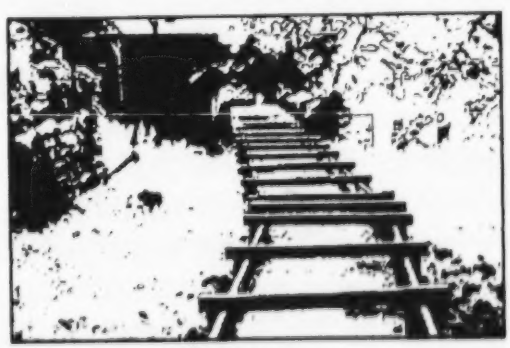
The cleaning shed was where the new castings were sent after cooling. Rough edges were filed off and all the sand that was burned onto the iron was removed. Moulders cleaned their own castings or paid others, including women and children, to do the work. The pay in 1836 was seventy-five cents a long ton (2,200 pounds) for cleaning castings. A ton was often as many as 1100 stove plates.

When the castings were finished, the company clerk inspected them, noted the number of perfect castings each moulder had made, and recorded these in the company ledgers. In 1835 the most successful moulder earned $352.24.

Overgrown Slag Pile between Cast House and Blacksmith Shop

Slag Pile

Before the furnace was tapped, the guttermen would remove the slag. Some was used to pave roads, but excess slag was piled in mounds outside the cast house and in the barnyard. Large amounts of unused slag, became a problem, since there was no other place to store it.

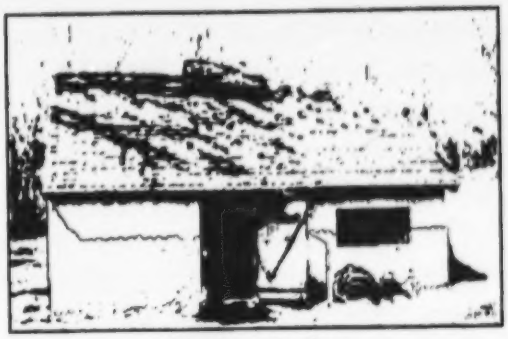


West Headrace

West Headrace and Waterwheel

Early ironworks used water power to operate the huge bellows which blew air into the furnace. For this reason Hopewell is called a "blast furnace" because blasts of air were pumped into the fire to speed up the smelting process. At Hopewell a dam built on French Creek created a small lake.

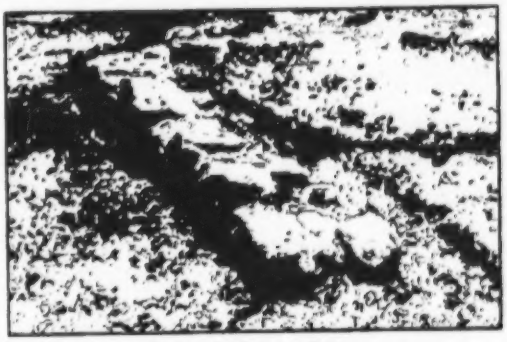
From this, a ditch or race carried the water which turned a large waterwheel. The water turned the wheel by filling each of its buckets. The race which brought the water to the waterwheel is called the headrace, while the one that carried the water back to the creek is called the tailrace. Rods attached to the axle of the wheel moved the bellows inside the wooden blowing tubs. Air was compressed inside these tubs and pushed through a pipe into the square box called the receiving box. From there, the air traveled down the long tube into a nozzle sticking into the furnace. This nozzle is called by a French name, "tuyere." The blast of cold air fanned the fire in the furnace.



Blacksmith Shop

Blacksmith Shop (7)

The blacksmith not only shoed the horses which carried the iron products to the market, but he also made various tools and hardware for the furnace and its workers.

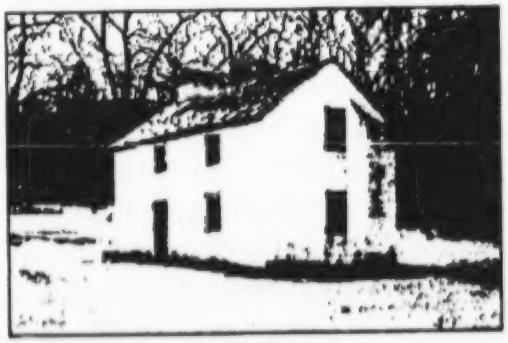


School House Ruins

School House Ruins (8)

The furnace school was built in 1836 by the furnace company, which was reimbursed by the school district. The furnace paid the school taxes for its employees, but the parents had to buy books, paper, and pencils for their children. Boys and girls were kept at separate sides of the school room and a disciplinary bench was placed near the teacher's desk in the center of the room.

Tenant Houses and Boarding House (9)



Tenant House

The tenant houses across the bridge were built by the furnace to house workers. Rent for the smaller houses was about $12 to $25 a year. At one time the furnace owned fourteen tenant houses, but not all of them were in the immediate vicinity of the furnace. Many of the Hopewell workers owned homes and farms nearby. Many of the tenants owned a milk cow, raised chickens, and grew vegetables in small gardens. The boarding house may date to 1807. The

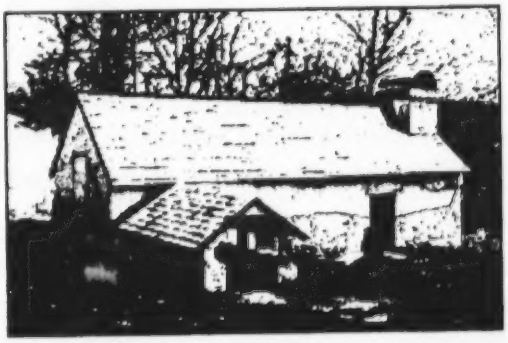
boarders were mainly single men who ate their meals at the moulder's kitchen in the basement of the ironmaster's mansion.

The Barn (10)

Barn

The animals sheltered in the barn were crucial to Hopewell's operation. The lower barn contained stalls for 36 horses. Sheep, poultry, hogs, and cattle were also raised to help feed the Hopewell community. Above the stalls were three hay mows which held enough hay to feed the animals for a year. Feed grain was stored in bins at opposite ends of the barn. Today the upper level of the barn houses a variety of horse-drawn wagons, carriages and sleighs. The horses, cows, sheep, and chickens you see today represent the large number of animals that were maintained by the furnace during its operation.

Springhouse and Smokehouse (11)



Springhouse

The cool spring waters supplied the ironmaster's family with drinking water. The trough in the middle room was like a refrigerator for the Big House. Crocks of food, milk, and butter lasted longer when placed in the cold spring water. The fireplace was used for melting fat to make soap and heating water for washing clothes.

Another way of preserving food was by smoking it. This method dried the meat, preventing spoilage. A smoky fire fueled by green wood or corncobs was built on the dirt floor after the meat was hung inside the smokehouse.

Ironmaster's Mansion (12)

The "Big House" served as the home of the ironmaster and his family. Several servants and the company clerk lived here too. Since there were no hotels near Hopewell, travelers and merchants often spent the night here. The Big House at Hopewell had nineteen rooms on four floors.

Around the back of the ironmaster's mansion is the moulder's kitchen, dining area, and the bake ovens. Because the moulders had to stay near the cast house during their shift, the company hired women to prepare and serve meals to them in the basement dining room of the Big House. The moulders paid about six dollars a month for three meals a day. The food for the ironmaster's family, however, was prepared in a kitchen upstairs.

Fresh bread was baked in the outdoor ovens. Wood fires heated the bake ovens. When the ovens reached baking temperature, the coals were raked out and the bread was inserted.

Ironmaster's Mansion

The East Headrace and the Ironmaster's Garden

Walk up the steps towards the Visitor Center. The small bridge near the Big House crosses the east headrace. Like the west headrace, this earlier ditch brought water to the waterwheel by diverting nearby streams. It is over a mile long. This headrace was likely constructed by slave laborers who were owned by Hopewell's first ironmaster, Mark Bird. Beyond the headrace are the remains of the ironmaster's garden.

On three terraces, and in the old greenhouse whose ruined wall can be seen to the right, the family grew vegetables, herbs, and flowers. Ice was cut from the lake in the winter and stored in an underground pit beneath the ice house that has long since gone to ruin.

Ironmaster's Garden

Name: _____

True or False Activity

Questions 1 to 15 are either TRUE or FALSE. Circle the correct answer:

1) TRUE or FALSE: Hopewell is much dirtier looking now than it was long ago when iron was being made there.

2) TRUE or FALSE: Limestone is the rock from which iron is removed.

3) TRUE or FALSE: We saw a pile of iron ore during our Hopewell visit.

4) TRUE or FALSE: There are more trees in the area of Hopewell today than during the ironmaking days in the 1800's.

5) TRUE or FALSE: Ironmaking was an easy job.

6) TRUE or FALSE: Animals and plants were needed by the people of Hopewell Furnace in order to make their lives easier.

7) TRUE or FALSE: Hopewell Furnace National Historic Site is located in Berks County in Pennsylvania.

8) TRUE or FALSE: Slag which can cut you is the waste product of iron production.

9) TRUE or FALSE: Charcoal is a dark product made from wood, and it can get you dirty.

10) TRUE or FALSE: Teamsters were the people who used horses to transport materials in wagons.

11) TRUE or FALSE: The "big house" is the house where all the single men lived at Hopewell.

12) TRUE or FALSE: The waterwheel was turned by water and used to blow air into the furnace at Hopewell.

13) TRUE or FALSE: A teacher is a person who gives lessons to a student.

14) TRUE or FALSE: Iron ore is a rock which cannot be melted.

15) TRUE or FALSE: A hostler took care of horses and other farm animals.

Name: _____ *Answer Key* _____

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Questions 1 to 15 are either TRUE or FALSE. Circle the correct answer:

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15) (TRUE) or FALSE: A hostler took care of horses and other farm animals.

Name: _____

Word Scramble

The letters to these words are scrambled. The sentences provide clues to the scrambled words. Place the letters in the proper order, and you will have a word dealing with Hopewell. You can use the following information sheets to aid you in finding the correct words for the exercise below: The Iron-Making Process and the Vocabulary Sheet.

1. _____ RONI — The main objective of the workers at Hopewell was to produce what metal?

2. _____ REO — The name applied to the natural rock containing iron that was removed from the Earth by the miners.

3. _____ LHOAACCR — This is the very black carbon fuel used to fire/heat the furnace so that the iron can be melted from the iron ore; this carbon fuel was produced from wood.

4. _____ EUCRNFA — The structure that was used by the founder to remove the iron from the rock ore.

5. _____ SNOMILEET — The "flux" or cleaning agent rock that was placed in the furnace with the iron ore and charcoal during the smelting process.

6. _____ TWARE — Liquid used to run the large wheel that supplies air to the furnace; this liquid was also used for washing, bathing, cooking, and other things.

7. _____ HLSKBTICAM — The person in the village who made special iron products by heating and hammering them into shapes; he may have made nails, candle-holders, horseshoes, forks, and other items.

8. _____ NOGWA — This vehicle transported charcoal and other items in the village; it was generally pulled by large draft horses, mules, or oxen, and manned by the teamster.

9. _____ LOLRICI — This is the person who produces the charcoal from the wood.

10. _____ ADIM — The woman who took care of the house chores for the ironmaster.

Name: *Answer Key*

Word Scramble

The letters to these words are scrambled. The sentences provide clues to the scrambled words. Place the letters in the proper order, and you will have a word dealing with Hopewell. You can use the following information sheets to aid you in finding the correct words for the exercise below: The Iron-Making Process and the Vocabulary Sheet.

1. *Iron*
   RONI
   The main objective of the workers at Hopewell was to produce what metal?

2. *Ore*
   REO
   The name applied to the natural rock containing iron that was removed from the Earth by the miners.

3. *Charcoal*
   LHOAACCR
   This is the very black carbon fuel used to fire/heat the furnace so that the iron can be melted from the iron ore; this carbon fuel was produced from wood.

4. *Furnace*
   EUCRNFA
   The structure that was used by the founder to remove the iron from the rock ore.

5. *Limestone*
   SNOMILEET
   The "flux" or cleaning agent rock that was placed in the furnace with the iron ore and charcoal during the smelting process.

6. *Water*
   TWARE
   Liquid used to run the large wheel that supplies air to the furnace; this liquid was also used for washing, bathing, cooking, and other things.

7. *Blacksmith*
   HLSKBTICAM
   The person in the village who made special iron products by heating and hammering them into shapes; he may have made nails, candle-holders, horseshoes, forks, and other items.

8. *Wagon*
   NOGWA
   This vehicle transported charcoal and other items in the village; it was generally pulled by large draft horses, mules, or oxen, and manned by the teamster.

9. *Collier*
   LOLRICI
   This is the person who produces the charcoal from the wood.

10. *Maid*
    ADIM
    The woman who took care of the house chores for the ironmaster.

Evaluation Form

We hope that we have served you well at Hopewell Furnace. In order for us to update and improve our educational program, we would appreciate completion of this short evaluation of our program.

Please return this form to the following address:

Superintendent
Hopewell Furnace NHS
2 Mark Bird Lane
Elverson, PA 19520

Program Date: _____ Ranger: _____

Teacher's Name: _____ Grade: _____

School Name: _____

Please check the appropriate evaluation for each question or comment presented below:

1. How valuable was the information presented?
   ❑ very valuable ❑ valuable ❑ not useful

2. How was the method of presentation?
   ❑ very effective ❑ satisfactory ❑ ineffective

3. Best describes the style of the Ranger?
   ❑ very effective ❑ adequate ❑ inadequate

4. How was the length of the program?
   ❑ just right ❑ too long ❑ too short

5. What was the value of the mold / cast hands-on lab?
   ❑ very effective ❑ effective ❑ not effective

6. Evaluate pre-visit materials.
   ❑ very effective ❑ effective ❑ not effective

7. Evaluate post-visit materials.
   ❑ very effective ❑ effective ❑ not effective

8. Over-all evaluation of this program.
   ❑ outstanding ❑ above average ❑ average ❑ below average

9. Are you likely to schedule this program next year?
   ❑ yes ❑ maybe ❑ no

10. Use the back of this paper for any additional comments or observations.

Fee Waivers for Educational Purposes

Hopewell Furnace National Historic Site welcomes the opportunity to provide interpretive and educational programs to your students. The park charges a $4.00 entrance fee for all adults (over age 17) as required by the National Park Service's Recreational Fee Demonstration Program.

This entrance fee can only be waived under the following guidelines:

Federal law provides for granting a fee waiver to *bona-fide educational and scientific institutions*, but the waiver is not automatically granted. To be provided a waiver, a group must apply in advance with:

1. A copy of documentation of its recognition as an educational institution by an appropriate governmental authority and,
2. A letter stating the specific relation of park resources to educational objectives. A statement that a visit is for "educational purposes" is not sufficient.

The school's letterhead is sufficient to verify official recognition for *public schools only*. Other educational institutions may use:

- an educational institution tax exemption certificate;
- a letter of recognition from an appropriate state or federal bureau; or
- a letter of accreditation.

The written request to waive fees, supported by documentation of educational accreditation, must be received at Hopewell Furnace National Historic Site prior to the date of your tour. If this request and documentation is not received and approved in advance, the adults in your group should be prepared to pay the entrance fee.

Documentation may be sent via mail (or fax to 610-582-2768), to the attention of the Park Education Coordinator. Please direct questions to the Park Education Coordinator at 610-582-8773.

On the reverse is a sample request for waiver of entrance fees for your use.

Sample Request for Waiver of Entrance Fees

Date _____

Dear Superintendent:

I am writing to request the entrance fee be waived for my school's visit to Hopewell Furnace National Historic Site on _____. We will be using the park resources for educational purposes.

Our trip to Hopewell Furnace National Historic Site has direct links to our curriculum. In social studies we focus on Pennsylvania history. Ironmaking has been discussed during our studies of life in the 1700's and 1800's.

We are hoping that this trip will give students a better understanding of how iron was made in Pennsylvania during the 18th and 19th centuries. This trip will illustrate and reinforce what our students have learned about the very important role ironmaking played in making our Commonwealth a vital part of our National economy.

Sincerely,

_____

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

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